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AUTHOR	Johnson, Kirk A.; And Others
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ABSTRACT

A study evaluated the efficiency of job-specific training in military technical areas other than electronics. It sought to determine whether individualized, computer-managed instruction (CMI) can be used to avoid some of the administrative difficulties common to more conventional forms of job-specific training, and it sought to determine the cost-effectiveness of this form of instruction. Individualized, job-specific courses were developed for three organizational-level billets in an A-7E squadron--power plant maintenance technician, structures/hydraulics maintenance technician, and plane captain. The courses were supported by the Navy's CMI system. Students, trained in the job-specific courses, tended to do better than conventionally-trained counterparts on a series of written and performance tests. They were rated about the same by supervisors on the job. Training time for the power plant and structures/hydraulics maintenance technicians were reduced by about one half. For plane captains, the reduction was only about 10 percent. Use of CMI alleviated many administrative difficulties. It was suggested that the initial high cost of material development could be offset in the future by training time reductions. Appendixes include outlines of course content and results of tests and questionnaires. (YLB)

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AN EVALUATION OF INDIVIDUALIZED, JOB-SPECIFIC MAINTENANCE TRAINING

Kirk A. Johnson
Linda L. Graham
Stuart B. Carson

Reviewed by
James S. McMichael

Released by
James F. Kelly, Jr.
Commanding Officer

Navy Personnel Research and Development Center
San Diego, California 92152

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Individualized, job-specific courses were developed for three organizational-level billets in an A-7E squadron: The TF41 power plant maintenance technician, the structures/hydraulics maintenance technician, and the plane captain. Training was oriented specifically toward the tasks that the graduate would perform in the billet during his first enlistment. Training on the more general or theoretical knowledge needed for a given task was closely integrated with training on the more specific or

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concrete aspects of the task, instead of being segregated into common-core courses at the beginning of the training pipelines. The courses were supported by the Navy's computer-managed instruction (CMI) system.

Students trained in the job-specific courses tended to do better than their conventionally trained counterparts on a series of written and performance tests. They were rated about the same by their supervisors on the job. Training times for the power plant and structures/hydraulics maintenance technicians were reduced by about half. For the plane captains, the reduction was only about 10 percent (there is no common-core training for this billet). The use of CMI alleviated many of the difficulties that have been encountered in providing job-specific training by conventional means.

FOREWORD

This development was conducted under advanced development objective 43-03X (Education and Training Development), subproject P13 (Computer-managed Instruction), which was initiated in response to a technical development plan submitted by the Chief of Naval Technical Training (CNTT). It was managed jointly by CNTT and the Navy Personnel Research and Development Center. Results are intended for use by training managers on the staffs of the Chief of Naval Operations (OP-01), the Chief of Naval Education and Training, and CNTT to support changes in managerial policy and as information on which to base long-range objectives and further research and development requirements.

The training evaluated in this report took place in 1974. Although the Navy has placed a strong emphasis on individualized, computer-managed instruction since that time, the progression from common-core preparatory to initial-skill courses to specialized courses is much the same now as it was then. Because the essential nature of common-core courses has not changed, results similar to these reported here might be obtained today.

Appreciation is extended to Mr. J. Harvell of CNTT, who supervised the development of the new computer software needed for the project and the procurement of computer hardware, and to the following people, who helped prepare the instructional materials: Mr. J. Andre, AD1 J. Fortner, TDC D. Ramey, AMSC L. Smittle, and PHC C. Wright of CNTT; and Mr. G. Brett and Ms. V. Weymouth of Memphis State University. Personnel of the Fleet Replacement Aviation Maintenance Program, Attack Squadron 122, who worked closely with the project staff during all phases of the study and provided training for students in both the conventional and job-specific training pipelines, deserve particular thanks.

JAMES F. KELLY, JR.
Commanding Officer

JAMES J. REGAN
Technical Director

SUMMARY

Problem

Research has shown that, when the entire technical training sequence is tailored precisely to the requirements of a specific job, students can be brought to a given level of proficiency more rapidly than when much of the sequence is adapted to the sometimes conflicting requirements of different jobs. In spite of these savings in training time, job-specific training has not been widely adopted by the Navy. There are a number of reasons for this apparent neglect, most of which stem from the fact that, as courses become more specific, the student population is dispersed into a large number of courses, each of which has a relatively small student input. This, in turn, leads to major difficulties in maintaining optimal student/instructor ratios, ensuring maximum utilization of equipment and facilities, and minimizing the time lost because there are not enough students to start a course.

Objective

The objective of this study was to determine the extent to which certain obstacles to job-specific training could be overcome through the use of individualized training techniques. Specifically, it was designed to determine whether (1) individualized, computer-managed instruction could be used to alleviate the difficulties associated with handling small student inputs, and (2) the reduction in training time afforded by such a system would be sufficient to offset the additional cost of preparing and delivering the special training materials.

Approach

A job-specific training course was prepared for each of three organizational-level billets in an A-7E squadron--power plant maintenance technician, structures/hydraulics maintenance technician, and plane captain. The training materials were designed to provide all the technical training needed to perform the duties normally performed in a given billet during a first enlistment. They were self-administered and relied heavily on slide-tape presentations. The training took place in the normal training spaces of a fleet readiness squadron, and included a large amount of practical work on operational equipment.

The job-specific materials were used to train recent graduates from recruit training. These students were compared with conventionally trained students on written and performance tests, training time, and supervisor evaluations of performance on the job. The costs and benefits of the job-specific training program were compared with those of the conventional training program.

Findings

Even though students in the job-specific courses had somewhat lower aptitude scores, they performed as well or better than the conventionally trained students. Their scores were substantially higher on the written tests. They were also substantially better on the power plant maintenance technician and plane captain performance tests, and were slightly better on the structures/hydraulics maintenance technician performance tests. Training times for the power plant and structures/hydraulics maintenance technicians were reduced by roughly 45 and 62 percent respectively. Plane captain training time, where there was no conversion from common-core to job-specific training, was reduced by 11 percent. The technicians' supervisors in the fleet indicated that both types of students

had been adequately trained and that there were no substantial differences in their performance on the job.

Conclusions

This study provides additional evidence supporting the efficiency of job-specific training. It also demonstrates that many of the difficulties associated with conventionally taught job-specific courses can be alleviated by using individualized, computer-managed instruction. The initial cost of developing the job-specific training materials was fairly high, but would have been offset quite rapidly by reductions in training time.

The results of this evaluation suggest that a fairly broad operational program of job-specific training would offer substantial cost savings. A number of questions about an operational program of this kind cannot be answered on the basis of the data provided here, however. There would obviously be complications and difficulties, but none appear to be prohibitive.

Recommendations

1. Training for a representative sample of billets should be analyzed (a) to estimate the potential benefits of a broad program of job-specific training and (b) to identify candidates for conversion to job-specific training. There is a particular need for information on the way in which training of this kind would work with billets on surface ships.

2. Job-specific training programs should be initiated for several billets where there are relatively few obstacles to implementation and large potentials for cost reduction. The programs developed under this project should be considered prime candidates, since (a) most of the developmental work has already been done and (b) major changes in other parts of the personnel system would not be necessary. Consideration should be given to implementing these programs on the aviation training support system, a system of small on-site computers being developed at the Naval Weapons Center, China Lake.

3. A systematic analysis should be made of the ways in which a broad program of job-specific training would interact with recruiting, detailing, cross-training, advanced training, advancement in rating, reenlistments, and career progression. Consideration should be given to modifications of existing procedures that might serve to facilitate job-specific training.

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INTRODUCTION

Background

Most military technical training progresses from the general to the specific and from the abstract to the concrete. A typical avionics pipeline, for example, teaches the principles and skills considered relevant to the maintenance of any electronic equipment, followed by those considered relevant to the maintenance of any radar, those considered relevant to the maintenance of any navigational radar, and, finally, those required to do a particular job, such as provide organizational-level maintenance[1] on an AN/APN-153 (V) doppler radar mounted in an A-7E aircraft.

This pattern of training has a number of advantages. First, it is cheaper to develop a few courses, each of which will be used by a large number of students, than to develop many courses, each of which will be used by a small number of students. Second, when several hundred students arrive each week for training in the same course, new classes can be convened weekly or even daily, without having to wait for students to trickle in and fill a specific class. Third, when a course is staffed by a large number of instructors, the arrival or departure of a single instructor is far less disturbing than when a course is staffed by a smaller number. Finally, every course requires a certain amount of direct and indirect support, and the cost of this support per student decreases as the number of students increases. Since these advantages are greatest in the early or "common-core" phases of training, the tendency is to move the maximum amount of training into these phases.

There are also a number of disadvantages. First, there is a tendency to interpret the term "common," as used to describe material taught in the early phases of training, too broadly. Job inventories reveal that much material needed for a given job will not be needed for other jobs served by the same common-core course. The more theoretical or abstract the material, or the more tangential it is to actual job performance, the more likely that it will be considered "common." This has led to a high concentration of such material in the early phases, even though students learn such material more rapidly and effectively when they can apply it immediately to the tasks that they will perform on the job. It has also encouraged teaching at a level of abstraction that is too high for optimal learning. Finally, too much reliance is placed on the fact that training on one system (the "teaching vehicle") can facilitate training on a second, similar system. In most cases, the student can learn the second system directly more rapidly than he can learn the two systems in sequence.

There are several organizational factors that contribute to the continuation of common-core training. Most of its advantages increase the efficiency of the training delivery system, while most of its disadvantages decrease the efficiency of the training itself. Variations in training efficiency are rarely obvious and are even harder to detect in a system that is fragmented into a number of relatively autonomous courses taught in different geographic locations and under different commands. Under such circumstances, it is natural that the people who manage the training delivery system focus on the advantages of common-core training.

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[1]DoD has divided its maintenance systems into three levels: organizational, intermediate, and depot. For naval aviation, the organizational level consists of work performed by the operating squadron on a day-to-day basis in support of its own operations. This includes such work as aircraft servicing, inspections, minor adjustments, and removal and replacement of parts and components.

Over the past 20 years, numerous studies have been designed to demonstrate the increased training efficiency provided by job-specific training, or training that is oriented directly toward one specific job, with none of the compromises required by common-core training. All have been successful, and many have demonstrated substantial improvements.

Problem

Despite the demonstrated efficiency of job-specific training, it has not been widely used in military training programs. Part of this neglect is due to the administrative difficulties cited previously. Part is due to the difficulty of ensuring that the student will be assigned to the job for which he has been trained.

Objectives

The purposes of the present study were to (1) evaluate the efficiency of job-specific training in areas other than electronics, (2) determine whether individualized, computer-managed instruction (CMI) can be used to avoid certain of the administrative difficulties common to more conventional forms of job-specific training, and (3) determine the cost-effectiveness of this form of instruction.

METHOD

Billets Selected for the Evaluation

Individualized, job-specific training materials were developed for three organizational-level billets in an A-7E aircraft squadron: (1) the TF41 power plant maintenance technician, (2) the structures/hydraulics maintenance technician, and (3) the plane captain. It was felt that three technically diverse billets in the same weapons system would provide an opportunity to explore (1) the extent to which certain training materials could be shared by students being trained for different jobs, and (2) the advantages and disadvantages of training students for different jobs within the same training spaces. Such a selection had the further advantage of minimizing certain computer-related costs by concentrating training in a single remote location.

A-7E billets were selected because the aircraft had (1) a large yearly requirement for trained technicians, (2) an operational history long enough to ensure a stable training program under the direction of experienced personnel, and (3) a life expectancy long enough to provide for the continued use of the materials developed under the project.

Two of the billets require additional comment. The structures/hydraulics maintenance technician billet is unusual in that initial skill training is conducted in one of two different courses, but graduates of both courses are used without distinction in a single billet. The plane captain billet is unusual in several respects:

1. It is not associated with a particular rating; some plane captains come directly from recruit training, whereas others come from one of several different initial skill courses.

2. It is generally temporary; the incumbent fills it through all or part of his first deployment and then moves on to another billet more closely related to his rating.

3. The training for this billet does not follow the conventional common-core pattern of the other two billets, so it does not permit a clear comparison between common-core and job-specific training. It was included in the project at the request of the trainers, who were concerned about the quality of training provided for this critical assignment. It also provides an opportunity to investigate the development and use of job-specific training for a series of tasks that differ considerably from those found in the other two billets.

Conventional Training

Training Sequences

Figure 1 is a summary of the technical training normally provided to first-term personnel destined for each of the three billets. A list of topics covered in these courses is included in Appendix A.

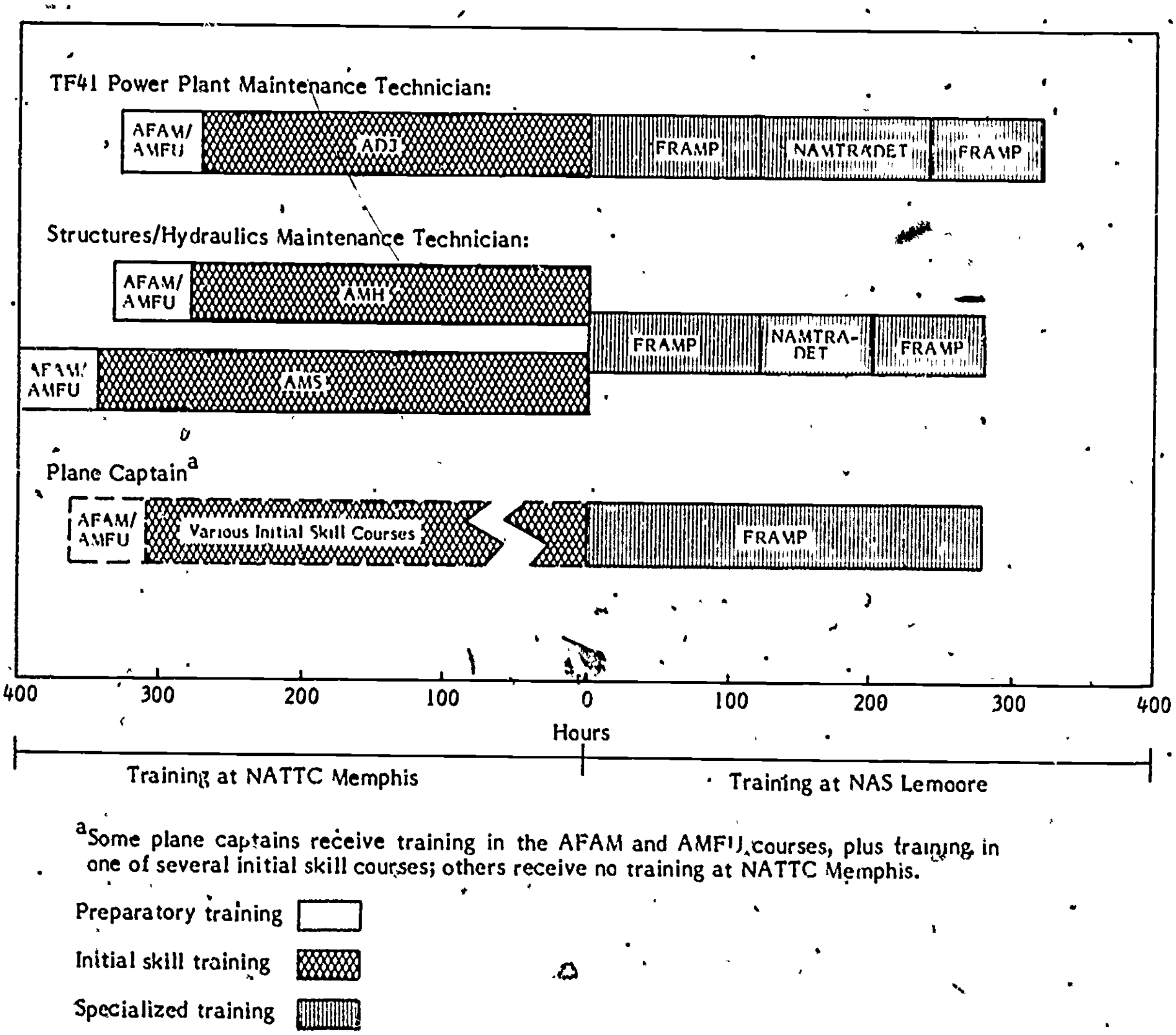

Figure 1. Conventional training pipelines.

The power plant and structures/hydraulics maintenance technicians are sent to the Naval Air Technical Training Center (NATTC), Memphis, for preparatory and initial skill training. Some plane captains also receive such training at NATTC but, at the time of this evaluation, most did not. During initial skill training, the student is asked to indicate his duty station preference. This information is coordinated with the projected needs of the operational squadrons, and the student receives orders to a readiness squadron, a training activity that prepares both officer and enlisted personnel for duty with a particular aircraft. Attack Squadron One-Two-Two (VA-122) at NAS Lemoore, California, provides such training for all A-7E squadrons deploying from the west coast. The Fleet Replacement Aviation Maintenance Program (FRAMP) is a department of the readiness squadron that is responsible for conducting and managing maintenance training.

Training Course Content

Preparatory Training. Preparatory training for the three billets consisted of two short CMI courses, the aviation familiarization course (AFAM), and the follow-on aviation mechanical fudamentals course (AMFU). AFAM provided 10 hours of general orientation to naval aviation and aircraft; and AMFU, 42 hours of instruction on the naval aviation maintenance program, maintenance publications, maintenance forms, and the use of common hand tools.

Initial Skill Training. Power plant maintenance technicians received initial skill training in the aviation machinist's mate J (Jet Engine) course (ADJ). This 278-hour course was designed to provide "the technical knowledge and skills that are basic to the field of turbojet propulsion and requisite for apprentice jet engine mechanics." Three general features of the course should be noted. First, its graduates would normally work on only one of a wide variety of jet engines. In order to provide information relevant to as many of these engines as possible, there was an emphasis on general topics, such as theory of operation and alternative designs. Some of this material may have aided subsequent learning or have had motivational value, but much of it was unrelated to any task that would actually be performed by the student. The second feature is almost the opposite of the first. Since many tasks would be almost meaningless if taught in the abstract, the J79 gas turbine power plant was used as a teaching vehicle. The particulars of this instruction were useful to students who subsequently worked on this engine but were largely irrelevant for the majority of students who would work on other engines (e.g., the TF41 turbofan power plant used in the A-7E). Finally, the training covered a mixture of organizational- and intermediate-level tasks. The training on tasks performed only at one level had little value for students subsequently assigned to jobs at the other level. These features are not stressed to suggest that this was an unusually bad course but, rather, to indicate that serious problems are inherent in any common-core course of this kind.

Structures/hydraulics maintenance technicians received initial skill training in either the aviation structural mechanic H (hydraulics) course (AMH) or the aviation structural mechanic S (structures) course (AMS). The mission of the 280-hour AMH course was to prepare the student "for successful completion of specific requirements for advancement in rating by providing that understanding and knowledge that are basic to the field of hydraulics." Like the ADJ course, it trained students who would work at either the organizational- or intermediate-level on one of a wide variety of aircraft. The problems inherent in training for such a variety of jobs were handled in a similar manner. There was a good deal of material on theory of operation, alternative designs, and particular procedures for aircraft other than the A-7E.

The mission of the 344-hour AMS course was to provide students with "the basic technical requirements for aviation structural mechanics S (structures), AMS third class." The problems faced in this course and the attempted solutions were similar to those in the other courses. In this case, however, the problems were further complicated by the fact that many types of structural repair taught in the course, and done at the organizational level on many aircraft, are not done at the organizational level on the A-7E.

Some plane captains are drawn from the initial skill courses (generally ADJ, AMH, or AMS); and others, directly from apprentice training. The proportions vary from squadron to squadron and from time to time with variations in the recruiting climate. At the time of this evaluation, most were drawn directly from apprentice training.

Specialized Training. Personnel in all three billets began specialized training with 120 hours of indoctrination and general training--called Phase I--conducted by FRAMP. The power plant maintenance technicians were then sent to the local Naval Air Maintenance Training Group Detachment (NAMTRADET) for 80 hours of formal instruction on the A-7E power plant and related systems, after which they returned to FRAMP for 80 hours of supervised practical training. The structures/hydraulics maintenance technicians were sent to NAMTRADET for 120 hours of instruction on A-7E structural, hydraulic, and pneumatic systems, after which they returned to FRAMP for 80 hours of supervised practical training. The plane captains received the remainder of their training--40 hours of formal school training, followed by 120 hours of practical training--in FRAMP.

Training Time

The power plant maintenance technicians received a total of 608 hours of training--328 at NATTC Memphis and 280 hours at NAS Lemoore. Structures/hydraulics maintenance technicians trained in AMH received a total of 652 hours--332 at NATTC Memphis and 320 at NAS Lemoore; those trained in AMS received a total of 716 hours--396 at NATTC Memphis and 320 at Lemoore. The length of training received by the plane captains varied widely, depending on what, if any, initial skill training they received at NATTC Memphis. However, they received a total of 280 hours at NAS Lemoore, regardless of previous training.

These estimates do not include time spent in travel, checking on or off a station, or waiting for classes to convene.

Job-specific Training

The job-specific training system developed and evaluated under this project differs from the conventional training system in a number of important respects. The general guidelines for developing the system were fairly simple: Training would concentrate on tasks performed by technicians in the specified billets during their first enlistment and would be supported and managed by the existing Navy CMI system. As much training as possible would be provided by self-administered instructional packages or highly structured practice on the tasks themselves.

Development of Job-specific Training Objectives

Tasks that represent minimum entry-level qualifications for first-term enlistees in each of the three billets were compiled from information on the planned maintenance system (PMS), the personnel qualifications standards (PQS), and the organizational

maintenance manuals for the A7-E aircraft (at the time of the study, the billets had not been surveyed as part of the Navy Occupational Task Analysis Program). These lists were reviewed by instructors from FRAMP and NAMTRADET, and by aircraft division officers from several of the operational squadrons at NAS Lemoore.

Most of the terminal training objectives were based directly on individual tasks from the task list. In such cases, the objective specified the following: (1) a sequential list of procedures for accomplishing the task, (2) the tools and material to be used, (3) the roles to be played by various technicians on multiperson tasks, (4) the conditions under which the students should be tested, and (5) the minimum satisfactory performance levels. Preliminary objectives were developed from various maintenance publications and reviewed by FRAMP instructors. Most differences in opinion were resolved by referring to the publications. Conflicts between publications were resolved by consulting personnel from the aircraft manufacturer (Ling-Temco-Vaught), the Naval Aviation Engineering Service Unit, or NAVAIRSYSCOM personnel responsible for the A-7E PMS. Conflicts due to variations in squadron procedures for line operations, aircraft handling, and other plane captain functions were resolved by the assistant FRAMP officer, who had an extensive background in A-7E line operations.

Enabling objectives were developed by working backward from the terminal objectives, first to relatively specific skills and knowledge of the type taught in the specialized courses, then to the more general skills and knowledge of the type taught in the initial skill courses, and, finally, to the very general skills and knowledge of the type taught in the preparatory courses. This was done by giving a list of the terminal objectives to the NAMTRADET instructors responsible for the specialized training of organizational-level power plant and structures/hydraulics maintenance technicians and asking them to prepare rough statements of enabling objectives (and a sample test item for each) that (1) reflected the skills and knowledge that were taught in specialized courses and (2) provided a basis for learning the terminal objectives. A review of these enabling objectives, by both the project staff and personnel from the initial skill courses, indicated that considerable revision would be required. A sample of the objectives submitted for structures/hydraulics maintenance technicians indicated that 9 percent were integral parts of the instruction that would be required for teaching one of the terminal objectives, 9 percent should be incorporated into a more general type of enabling objective appropriate to initial skill training, and 39 percent were not related to the terminal objectives. The latter included both nice-to-know information that was quite remote from actual performance and information that was relevant only to intermediate-level maintenance. This left only 43 percent of the objectives that had been submitted originally. In a sample of the objectives submitted for power plant maintenance technicians, approximately 12 percent were integral parts of the training that would be provided on terminal objectives, 11 percent were more appropriate for initial skill training, and 53 percent were judged to be irrelevant. This left only 24 percent of the original objectives. Borderline cases were discussed with both FRAMP and NAMTRADET personnel. The final list was checked against the publications for technical accuracy, converted to the prescribed format, and approved by both FRAMP and NAMTRADET personnel.

Since there are no initial skill or NAMTRADET schools specifically for plane captains, enabling objectives were developed differently for this billet than for the other two. Preliminary statements of knowledge factors were provided by the FRAMP. These were converted to specific objectives by project personnel and then returned to the FRAMP for final approval.

Project personnel and personnel from the relevant initial skill courses used the terminal objectives and the revised specialized training enabling objectives as a basis for developing enabling objectives of the type generally taught in initial skill courses. Finally, project personnel developed objectives of the type generally taught in preparatory courses. Most of these were enabling objectives, but some covered topics that were not related to the specific tasks on the task lists (e.g., a general familiarity with aviation ratings). Since the objectives for AFAM and AMFU had recently been reviewed by project personnel for relevance to the aviation machinist's mate and aviation structural mechanics ratings, only minor modifications were required.

Training Sequences

Job-specific training for each of the billets was divided into three separate courses. The first course, which was the same for all billets, consisted of 84 hours of training from Phase I of the conventional FRAMP curriculum (16 hours of general indoctrination, 16 hours on firefighting, 12 hours on driver training, and 40 hours on ground-support equipment). This course was taught in the conventional manner, and required no new training materials.

The second set of courses, which were called "preparatory" courses, covered objectives similar to those in AFAM and AMFU. Many of the instructional modules were drawn directly from the AFAM and AMFU courses. Other material was modified slightly to reflect A-7E aircraft. The third set of courses, which were called "specific billet" courses, provided training that was specific to a particular job or billet. The preparatory and specific billet courses were separated for administrative convenience. Since FRAMP trains many students who have already learned the material in the preparatory courses, these students were not assigned to a preparatory course.

Appendix B lists the instructional modules included in the preparatory and specific billet courses. Most of the modules used in the preparatory courses for one billet were also used in such courses for one or both of the other billets. However, only 11 of the 167 modules used in the specific billet courses were used for more than one billet.

Administration of Job-specific Training

All three courses for each billet were taught in FRAMP. This minimized student travel and facilitated the coordination of training with the needs of the operational squadrons. Also, it permitted a more effective integration of the abstract and concrete elements of the courses, since the progression from general to specific could take place at the level of tasks rather than courses. A typical instructional sequence might begin with explanations of why a specific system was needed and how it related to other systems (initial skill material), followed by descriptions of its configuration and operation in the A-7E (NAMTRADET material), an audiovisual program on a specific maintenance operation, and practice on the aircraft (FRAMP material).

Computer-managed Instruction (CMI)

The Navy CMI system was used to manage both the preparatory and specific billet courses. The courses consisted of a series of instructional modules, each covering a unified task or a closely related set of topics. Both the instructional materials and tests were presented off line. A module was initiated by a computer-printed assignment that directed the student to a set of instructional materials or to some task that he was to perform. When it directed him to instructional materials, it also specified which of several parallel module tests he should take when he completed the assignment. The tests

were evaluated by the computer. If a student failed to meet any of the criteria for any part of a module test, the computer would generally tell him to review that part of the module and assign a test on the part to be reviewed. Once the student had exhausted all available remedial assignments, the computer would send him to the instructor for individual help. When a student had met all criteria for a given module, whether on the original module test or through remedial assignments, the computer printed a new assignment.

Assignments to performance tasks differed from those made to other forms of instructional materials. Since performance tasks might be delayed for a variety of reasons, the assignment generally included, in addition to the basic assignment, a secondary assignment to the material that would normally follow the performance task, allowing the student to continue constructive study. Work on performance tasks was observed, recorded in detail, and evaluated (frequently against fairly complex criteria) by the instructor. The overall results were generally coded as acceptable or not acceptable on an answer sheet that was then submitted to the computer. If the student's performance was not acceptable, he was told to review the preparatory materials before trying the task again.

The final type of assignment was a comprehensive test. These tests, which were assigned after every 12 or so modules, contained questions parallel to every question that had been asked on the intervening module tests. Grading standards were the same as those for the module tests, and failures to meet criteria were followed by remedial assignments of the same kind used for the module tests.

Each day the computer printed a roster of all students registered in each course. It indicated each student's current assignment, how long he had been in the course, how much longer it should take him to graduate, and an estimate of how much faster or slower he was than other students of comparable ability.

The system was supported over a dedicated leased line by a computer located in Memphis.

Development of Training Materials

Performance Tests. A check sheet was developed for each terminal performance objective. These check sheets listed steps to be observed by the instructor in evaluating a student's performance, provided a means for recording observations, and gave standardized instructions to be read to the student at the beginning of each task. Whenever possible, multiman tasks were designed so that each student could perform only the critical portions of the task, without having to repeat the whole task in each position. Supplemental sheets provided the criteria for each step of the task and indicated which errors could be corrected by the instructor on the spot and which required an additional review of the instructional materials and a repetition of the performance test. A single incorrect step rendered performance unacceptable if it created (1) a degraded condition in the equipment that would not normally be detected and corrected at some later stage in the task, or (2) a condition that was dangerous to either personnel or equipment if not corrected immediately. An excessive number of mistakes, even if safe and correctable, was also unacceptable. These explicit standards were normally developed by the FRAMP personnel who would administer the tests but were reviewed by project personnel.

Aviation technicians are directed to use NAVAIRSYSCOM publications, including Maintenance Requirement Cards (MRCs), rather than rely on memory for such things as task sequences, adjustments, and torque values. The students used MRCs when they were

available. When they were not available and the technician would normally have used a technical manual, the students were given special job performance aids abstracted from the manuals. These usually listed the steps to be performed but not the information needed to perform them. They provided no information that was not in the manuals.

Written Tests. There were at least two forms for each module test and three for each comprehensive test. Additional forms were prepared when the material was unusually difficult or when a module was not subdivided into topics that could be tested separately. The written tests used for audiovisual programs could not always provide complete coverage of all objectives, but they did provide a means for stressing safety precautions, checking the care with which the student had studied the materials, and tracking him on the computer. Table 1 shows the number of written tests of different kinds prepared for the various courses.

Table 1

Number of Written Tests

Type of Course	Billet	Type of Test: Module & Topic	Type of Test: Comprehensive	Total
Preparatory	All three (total)	288	94	382
Specific billet	Power plant maintenance technician	188	27	215
Specific billet	Structures/hydraulics maintenance technician	243	39	282
Specific billet	Plane captain	145	27	172
Total		864	187	1051

Selection of Media. Rather simple guidelines were used for the selection of media. There was little need for depicting motion, and the few tasks that might have been taught more effectively by motion pictures or television did not warrant the additional expense of such equipment. Most training fell into one of two categories: (1) that which required many detailed visuals, particularly visuals in color, and (2) that in which visuals played a subordinate role. For example, modules that required the identification of aircraft components in extremely crowded locations or that detailed the step-by-step disassembly, inspection, and reassembly of such components lent themselves to color-slide and audiotape programs. Modules that dealt with such things as nomenclature and conceptual information, or that required line drawings, charts, graphs, or black and white photographs (particularly when such visuals were readily available from standard maintenance manuals) lent themselves to printed booklets.

Modules in the preparatory courses used printed booklets augmented by a few audiovisual programs for shop work. Table 2 shows the number of printed and audiovisual programs for each specific billet course.

Table 2

Printed and Audiovisual Programs in Specific Billet Courses

Billet	Type of Program	
	Printed	Audiovisual
Power plant maintenance technician	14	64
Structures/hydraulics maintenance technician	30	41
Plane captain	7	27

Audiovisual Programs. Most audiovisual programs consisted of a step-by-step depiction of each activity required for the successful performance of a terminal objective. These programs, which were developed very rapidly by enlisted personnel, were quite effective. The approved objectives and maintenance instructions were used as a basis for writing narrative descriptions of each step and detailed specifications for the visuals that would illustrate them. Much of the editing was done at this stage of development.

The actual photography was done at NAS Lemoore by a team of two Navy photographer's mates and three military instructional material developers, assisted by instructors from FRAMP. After the slides had been approved and the script edited, the narration was recorded, edited, and reproduced on cassettes.

Audiovisual materials were presented on a rear projection slide viewer with a built-in cassette tape-playback unit. Slide changes were controlled by the student. The playing times for the audiovisual programs ranged from 1 minute, 50 seconds to 28 minutes, 55 seconds. The average playing time per program was 8.5 minutes. Playing time, however, was generally far less than study time, since the tape was frequently stopped to study visuals, to repeat difficult segments, or to answer embedded test items.

Printed Booklets. The technique used in preparing instructional texts has proved to be quite sucessful in terms of both the effectiveness of instruction and the efficiency of production. The information was presented in a concise narrative form, followed by a practice test that covered every objective taught by the text. These tests served several purposes:

1. They converted the texts into what are normally referred to as adjunctive programs.

2. They minimized interactions with the computer, since the student was told not to take a module test until he could answer all the questions on the practice test.

3. They provided a convenient mechanism for specifying the topics to be restudied in a remedial assignment.

4. They provided a powerful means for branching around material that the student already knew.

The correspondence between practice questions and most enabling objectives was so close that a student with some experience could glance at the test and decide whether he needed to read the text. If not, he could take the module test and move on to the next assignment with little loss of time. The remedial assignments were viewed as an integral part of the instructional materials and as a major means for adapting the materials to individual differences.

Training Facilities and Support

The training spaces were located in an enclosed bay adjacent to the open hangar area. Most of the bay was devoted to a learning center that contained 64 student carrels. A separate, semi-enclosed area within this space was set aside for the shop used during the preparatory courses. Another semi-enclosed area was set aside for an engine trim-trainer and a stand-mounted TF41 engine (these were normally located in NAMTRADET, but were borrowed for the duration of the job-specific training). Most work on the aircraft was done in the hangar area immediately outside the learning center. Certain tasks were done in a cockpit orientation trainer located in another bay within the same hangar, on the apron outside the hangar, in the fuel pits near the hangar, or on the flight line.

To make the best use of available equipment, FRAMP normally has two training shifts. During job-specific training, the power plant maintenance technicians and plane captains were trained between 0730 and 1600, with a 1-hour lunch break; structures/hydraulics maintenance technicians were trained between 1600 and 2300, without a major break for meals.

The use of two shifts for job-specific training did not eliminate all competition for equipment, and sometimes an appropriately trained team was not available for work on a team task. When such problems occurred, the student skipped the performance task, continued with subsequent assignments, and returned to the task when the equipment or additional members of the team became available. Three special tools, including two daily computer reports, were developed to facilitate this rescheduling:

1. The first computer report, a roster of all students with outstanding performance assignments and the length of time that each assignment had been outstanding, was used primarily to avoid lost assignments and the neglect of minor tasks. A delay of more than 3 training days required an explanation to the assistant FRAMP officer.

2. The second report, which gave instructors a tool for scheduling scarce equipment and forming teams for multiman tasks, listed the performance tasks for each course and, under each:

a. The names of the students currently assigned to the task and how long they had been assigned.

b. The names of the students who would probably be ready for the task within the next 20 hours and a prediction of how long it would be before they were ready.

c. The names of students who had completed the task within the last 20 hours and how long it had been since they had completed it.

3. The third scheduling tool was a large board divided into a student-by-module matrix for each course. A blue magnetic chip indicated the last module completed by the student; and a red chip, an outstanding assignment to a performance task. Although the

information on this board duplicated some of the information provided on the computer-generated reports, it was more accessible and provided a vivid indication of trouble spots.

During the day shift, the learning center was manned by three machinist's mate instructors (two regular FRAMP instructors and one instructor who would normally have taught the NAMTRADET power plant maintenance technician course), and three plane captain instructors (all from FRAMP). During the evening shift, the learning center was manned by three structural mechanics instructors (two regular FRAMP instructors and one instructor who would normally have taught the NAMTRADET course for structures/hydraulics maintenance technicians).

Two project staff members were generally in the learning center to provide help, consultation, and instruction on the operation of the new training system and to ensure that project policies were being followed on a day-to-day basis. Occasionally, they helped with the routine operation of the center, but there was a consensus that, following the initial shakedown period, the system could have been run effectively by the FRAMP and NAMTRADET personnel without outside assistance.

Procedures for Comparison

Training Schedule

Data on conventionally trained students were collected from graduates of the four or five FRAMP classes that immediately preceded the job-specific training program. It was assumed that these classes would provide data on 20 to 25 first-enlistment students for each billet. The job-specific training lasted a little over 3 months.

Students

Students are normally ordered to the readiness squadron for further transfer to one of the operational squadrons because there is an existing or predicted vacancy in a particular work center in that squadron. However, during the period of job-specific training, the Bureau of Naval Personnel (BUPERS) agreed that students from the initial skill courses in Memphis would not be assigned to either the power plant or structures/hydraulics work centers of the operational squadrons served by VA-122. Instead, BUPERS would assign recruit training graduates who had not been scheduled for initial skill training, making an effort to select those with aptitude scores high enough to have qualified them for such training. Most students with scores this high had been guaranteed initial skill training at the time of their enlistment, and the Navy was unwilling to classify the job-specific courses as initial skill courses to fulfill this guarantee. However, students who had enlisted for only 3 years were not allowed to attend initial skill courses, and it was assumed that the number of such students would be sufficient to meet the requirement of the power plant and structure/hydraulics work centers.

Students destined for the line work center (plane captains) were to be selected as they had been prior to the job-specific training program.

Criteria for Determining Training Effectiveness

Performance Tests. At the completion of FRAMP training, the conventionally trained students were tested on a subset of the tasks tested as terminal objectives in the corresponding job-specific courses. The number of tasks was limited by the amount of time and resources available for testing the conventionally trained students. These students were not tested on tasks that (1) contained a large number of elements to be

tested in other tasks, (2) were not normally taught in FRAMP, or (3) could be performed by a substantial number of technicians prior to training. There were 27 tasks for the power plant maintenance technicians, 22 for the structures/hydraulics maintenance technicians, and 15 for the plane captains. Performance was timed and was graded by the standards used for the job-specific courses.

Written Tests. At the completion of FRAMP training, the conventionally trained students took a written test covering all items normally contained in the comprehensive tests for the corresponding job-specific courses. For the power plant maintenance technicians, the test contained 381 items; for the structures/hydraulics maintenance technicians, 499 items; and for the plane captains, 365 items.

Fleet Questionnaires. Three months after conventional or job-specific course graduates arrived at their operational squadron, their supervisor was asked to complete a questionnaire containing several general questions, followed by an exhaustive list of tasks for the billet on which training had been requested. For each task, the supervisor was asked to indicate whether he had observed the technician performing the task and, if so, how much additional training in the squadron had been required before the technician reached an acceptable level of proficiency.

RESULTS

Types of Students

Table 3 summarizes the numbers and types of students trained during the evaluation. The recruits came directly from a recruit training center; the initial skill students, directly from an initial skill course at NATTC Memphis; and the experienced students, directly or indirectly from an assignment to some aircraft other than the A-7E. Most experienced plane captains were unrated and had no initial skill training; most experienced technicians in the other billets were rated and had received initial skill training in the course appropriate to their assigned billet. For each billet, the two groups that provide the most direct comparison between job-specific and conventional training have been underlined. Unless specifically noted, the analyses are limited to these six groups.

The conventionally trained students from the initial skill courses had higher aptitudes than their recruit counterparts in the job-specific courses. There was a difference of approximately one standard deviation ($p < .05$) on a composite score from the Basic Test Battery. Only 40 to 50 percent of the students in the job-specific courses for power plant and structures/hydraulics maintenance technicians would have qualified for initial skill training. There was little difference between the two groups of recruits trained as plane captains.

Comparison of Conventionally Trained and Job-specific Students

Performance Tests

Acceptable Performance. Table 4 summarizes several criteria for evaluating job-specific and conventional training. Percentages of acceptable performance were computed by finding the percentage of students in each group who demonstrated acceptable performance on each of the tasks common to the two groups and then averaging these percentages over tasks. All job-specific groups did well, as did conventionally trained structures/hydraulics maintenance technicians. However, the

Table 3

Training Background of Students Trained Under Conventional and Job-Specific (J-S) Methods

	Billet and Type of Training					
	Power Plant Maint. Tech.		Struct./Hyd. Maint. Tech.		Plane Captain	
Background	Conv.	J-S	Conv.	J-S	Conv.	J-S
Recruit	--	21	--	18	26	23
Initial skill	12	3	15	4	3	8
Experienced	8	13	5	10	2	7
Total	20	37	20	32	31	38

Note. Underlined groups provide most direct comparisons between job-specific and conventional training.

Table 4

Criteria for Evaluating Job-specific (J-S) and Conventional Training

	Power Plant Maint. Technician		Struct./Hyd. Maint. Technician		Plane Captain	
Comparison Criterion	Conv. (Initial Skill)	J-S (Recruit)	Conv. (Initial Skill)	J-S (Recruit)	Conv. (Recruit)	J-S (Recruit)
Performance Tests:						
% Acceptable	44	96	95	99	69	98
Average Time (min)	— [a]	— [a]	47	42	20	21
Written Tests						
% Correct	56	90	51	89	55	88
Training Time (hr)	608	335	684[b]	263	280	249

[a]Performance times were not computed for these groups.

[b]Time for initial skill training computed as average of AMS and AMH.

latter results must be qualified by the fact that certain tasks the student would be required to perform on the job had been eliminated from the set of common tasks because they were not taught as part of the conventional instruction. The conventionally trained power plant maintenance technicians and plane captains performed poorly.

The data base for the conventionally trained power plant maintenance technicians was limited by (1) the small number available for training, and (2) a shortage of engines during part of the performance testing period. Because of this shortage, it was impossible to test all students on all tasks, so individual students were assigned subsets of tasks in a manner that provided a moderately uniform coverage for each task. To compensate for these limitations, a second comparison was made using all students trained in the conventional FRAMP course. The addition of the experienced students almost doubled the number of observations per task, but the average percentage of acceptable performances increased only slightly (from 44% to 49%). Appendix C provides summaries of performance on individual tasks.

Performance Times. Performance times were computed by finding an average time for each group on each of the tasks common to the two groups and averaging these averages over tasks. The overall differences between groups were small, but there were larger variations on individual tasks. On some tasks, the job-specific group was much faster than the conventional group; on other tasks, the opposite was true. The latter differences suggest areas in which the job-specific training materials might have profited from revision. Appendix C provides summaries of times on individual tasks.

Performance times were not computed for the power plant maintenance technicians because of irregularities in the times recorded for both groups.

Written Tests

Students trained in the job-specific courses did well on written tests; conventionally trained students did poorly.

Training Times

Students trained in the job-specific courses required substantially less training time than did conventionally trained students. Time was reduced by 45 percent for power plant maintenance technicians and by 62 percent for structures/hydraulics maintenance technicians. Even for the plane captains, whose training was already job-specific, time was reduced by 11 percent.

In several respects, these estimates are somewhat conservative. The times represent scheduled classroom time only. If they had included all time between graduation from recruit training and arrival at an operational squadron, including time required for travel, waiting for orders, and waiting for classes to convene, the relative differences would have been larger. Also, the plane captain preparatory course provided training on a number of general topics that was not provided to the conventionally trained students. If this material had not been taught, the difference in training time would have doubled. Finally, the relative differences in completion times between the job-specific and conventional training sequences were limited because there were fairly large blocks of identical or nearly identical material in both training sequences. The 84 hours of conventional Phase I FRAMP training was identical for all billets, and the preparatory courses, which accounted for roughly a third of the individualized training time, were quite similar in terms of both content and method of presentation to most of the conventional AFAM and AMFU courses. If this material had been excluded from the comparisons (i.e., if the focus

had been limited to specific billet courses and their common-core equivalents), the relative differences would have been much larger.

Attitude Questionnaires

Immediately prior to graduation from FRAMP, each student filled out an attitude questionnaire. The first 16 items were common to all groups and all billets, and the next 5 were specifically tailored either to recruits in job-specific training or to conventionally trained power plant and structures/hydraulics technicians.

Responses to the first 16 questions were scored on scales ranging from 1 (favorable) to 5 (unfavorable). Averages computed over these questions for the six groups most directly relevant to this evaluation fell within .3 point of one another and no difference was statistically reliable. The overall average was 2.6, indicating a slightly favorable attitude. Responses to individual questions are summarized in Appendix D.

Supervisor Questionnaires

Returns from the supervisor questionnaire, which provided information on the performance of technicians assigned to the fleet, are summarized in Table 5. Approximately 80 percent of the questionnaires were returned, a fairly high return rate for mailed questionnaires. The intervals between graduation and the return of the questionnaires ranged from 4 to 18 months, with an average of about 8 months. The rate of return varied from 92 percent for conventionally trained plane captains to 50 percent for conventionally trained power plant maintenance technicians. The rate of return did not appear to be systematically related to type of training or student aptitude. Data could not be obtained for several students because they were no longer with their assigned squadron.

Only 62 percent of the students for whom questionnaires were returned and who were in their assigned squadrons were actually working in the billet for which they had been trained. The percentage of proper assignments was higher for the conventionally trained students than for job-specific students (75 vs. 50%, $\chi^2 = 4.54$, $p < .05$). This was true even though each squadron commander had been sent a letter extolling the virtues of the job-specific training program and detailing the tasks that could be performed by its graduates. Much of this difference was due to the plane captains, the billet for which such a difference was least expected. When the plane captains are eliminated from the comparison, the difference between the conventionally trained and job-specific students decreases considerably (50 vs. 41%, $\chi^2 = .08$, $p > .05$), but so does the overall percentage of proper assignments (45%). Proper assignments did not appear to be systematically related to student aptitude.

A summary of ratings from the supervisor questionnaire is provided in Table 6. Summaries of the average ratings on individual tasks are provided in Appendix E. Of the 18 comparisons between the two types of training, only that for training plane captains in the FRAMP is statistically reliable (< .05). This evaluation by supervisors, which favored conventional training for plane captains, was quite different from that of the FRAMP training personnel who provided both types of training. The FRAMP personnel felt that the job-specific materials provided a major improvement over conventional training, and continued to use the job-specific materials after the study was completed (with the instructors performing certain functions originally provided by the computer).

Table 5

Summary of Returns of Supervisor Questionnaires

Item	Power Plant Maint. Technician		Struct./Hyd. Maint. Technician		Plane Captain	
	Conv. (Initial Skill)	J-S (Recruit)	Conv. (Initial Skill)	J-S (Recruit)	Conv. (Recruit)	J-S (Recruit)
Technicians evaluated (and in right billet)	4	7	5	5	21	10
Technicians not evaluated:						
Questionnaires not returned	6	3	2	5	2	6
Technician not in squadron	-	2	1	-	2	2
Technician in wrong billet	2	9	7	8	1	5
Total	12	21	15	18	26	23
Mean Apt. (GCT+ARI+Mech):						
Technicians evaluated	157	148	160	150	139	137
Technicians not evaluated	163	148	165	152	133	138

Table 6

Ratings of Conventionally Trained and Job-specific (J-S) Students in the Fleet

Criterion	Power Plant Maint. Technician		Struct./Hyd. Maint. Technician		Plane Captain	
	Conv. (Initial Skill)	J-S (Recruit)	Conv. (Initial Skill)	J-S (Recruit)	Conv. (Recruit)	J-S (Recruit)
Framp training[a]	2.25	2.14	2.40	2.20	1.81	2.40
Progress toward competence[a]	1.75	1.75	1.60	1.40	1.65	2.00
Motivation or initiative[a]	1.75	1.29	1.40	1.60	1.50	1.80
Proficiency[a]	1.75	1.71	1.80	1.40	1.65	2.00
Average task rating[b]	1.61	1.96	1.91	1.99	2.11	2.13
% Tasks assigned	79	74	92	80	89	94

[a]Based on responses to a 3-point scale, where 1 = favorable and 3 = unfavorable.

[b]Based on responses to a 4-point scale, where 1 = capable of performing job with no additional training, and 4 = required a substantial amount of training.

For the power plant and structures/hydraulics maintenance technicians, ratings on the first four criteria listed in Table 6 were higher for job-specific students than for conventionally trained students; the opposite was true for plane captains. The supervisors seemed to feel that the training provided by the FRAMP was slightly less than adequate, but that the students were slightly more than adequate, regardless of the type of training received.

The average task ratings followed a different pattern. There were essentially no differences for the structures/hydraulics maintenance technician and plane captain billets, but there was a large difference, favoring the conventionally trained students, in the power plant maintenance technician billet. This lack of agreement was also reflected in the within-group correlations between this criterion and the first four, which averaged only .35. In general, the task ratings fell close to 2 (capable of performing job with little additional training).

The final criterion, percentage of tasks assigned, was included because a failure to assign the more difficult tasks might reflect a lack of confidence in the technician's ability. However, the within-group correlations between this variable and the ratings, which averaged only -.12, suggest that variations in estimated ability had little influence on variations in the number of tasks assigned.

COST ANALYSES

Program Cost Estimates

It is difficult to estimate what the job-specific courses would have cost if they had been developed as part of an operational program, since many costs, particularly salaries, were influenced by the fact that the project was (1) experimental (e.g., data were collected), (2) the first of its kind (e.g., programs were developed to help with scheduling), and (3) an isolated effort (e.g., certain things were done under contract that could have been done more economically on a routine basis by military or civil service personnel).

Table 7 provides estimated costs adjusted for factors of the type mentioned above. These estimates are based on the assumption that the courses would be implemented in VA-174 at NAS Cecil Field, the east coast readiness squadron for the A7-E, as well as at NAS Lemoore. Thus, the reported costs in all except the first category are twice the estimated costs for implementation at a single site.

The largest cost category covers the actual design and development of the courses. The largest element in this category is compensation for approximately 15 man-years of work by Navy enlisted men (POIs and CPOs), who did most of the course development. (Cost estimates were taken from data provided by the Comptroller of the Navy, which include certain benefits in addition to straight salaries.) This element does not include the time spent by personnel from FRAMP or NAMTRADET in reviewing the task lists, objectives, and final instructional materials (this work was generally done when time was available during normal duty hours and would have been impossible to quantify with any precision). The second largest element in this category was pay for approximately 6.5 man-years of work by civil service employees, who supervised the development of the instructional materials, edited the materials, arranged for the procurement of equipment and the production of materials, coded the courses for the computer, and provided typing and keypunching. Cost estimates were taken from the salaries of professional personnel plus an arbitrary 60 percent for overhead. The travel costs represent, for the most part, trips to and from Lemoore by project personnel, plus a few trips to and from Memphis by FRAMP personnel. This element also includes per diem and related costs. The equipment costs cover such things as recording equipment, cameras, film, and rental of special typewriters.

The second category covers the production of slides and tapes for the audiovisual programs and the printing of instructional booklets and tests. The latter were priced at the reimbursement rate for short runs at the local Navy printing facility.

The third category covers the cost of preparing and equipping the learning centers. Most elements are self-explanatory. The cost of modifying spaces for the learning centers (including wiring and the construction of storage space for the instructional materials) might vary considerably, depending on the nature of the spaces available. The costs cited here do not include a considerable amount of work provided by FRAMP personnel. On the other hand, the learning center at VA-122 was capable of handling almost twice the average expected number of students in these billets. Some of this extra capability was needed to handle normal fluctuations in input, but not as much as was actually provided.

The final category covers compensation for four CPOs per site for a period of approximately 3 months, plus travel and per diem. The shipping costs are limited to shipments from Memphis; the costs of shipping items directly to the FRAMP from the manufacturer were included in the cost of the items.

Table 7

Cost of Job-specific Courses

Category	Costs ($)
Development of Materials	
Military pay	211,050
Civil Service pay	148,168
Travel	10,000
Equipment	10,300
	379,518
Production of Materials	
Slides	24,000
Tapes	5,000
Printing	6,400
	35,400
Learning Centers	
Carrels	11,800
Modification of spaces	7,000
Caramates	32,000
Slide trays	3,064
Multiplexers	10,810
Chairs, cabinets, etc.	1,020
	65,694
Initiation of Program	
Military pay	36,740
Travel	20,000
Shipping	500
	57,240
Total	537,852

The figures in Table 7 do not cover support of the courses while in operation. It is assumed that the courses, once they were operating smoothly, could be supported by the instructors from FRAMP and NAMTRADET who are normally responsible for training these students, so there would be no additional cost for instructors. There would be additional costs for expendables (e.g., answer sheets and paper for the printers), terminals, communication equipment, and the support provided by the central computer. It is difficult to estimate the cost of replacing such things as worn audio tapes, but there is probably enough overage in the estimates for the initial supplies to cover replacement for several years.

Expendable materials for the two sites would cost about $350 per month. Terminals and communication equipment of the kind actually used during this project would cost $6,464 per month, but the batch terminals and communication lines, which represent the major part of this cost, could be used to support all the students trained in the FRAMPs,

or about four times the number of students trained in these courses. Central-site computer support (hardware, personnel, and equipment), according to current estimates, would cost about $1,000 per month. The total of these operating costs is $7,814 per month, or $93,768 per year. If the cost of batch terminals and communication equipment were shared proportionately with additional courses, the total cost of support for the courses considered here would be reduced by about 50 percent.

Cost Reduction Achieved by Job-specific Training

The major benefits of job-specific training stem from reduced training time. The actual cost reduction is a function of (1) the amount of time saved, (2) the cost of maintaining a student in training, and (3) the number of students that pass through training. Although fairly good estimates can be made for the first two factors, there are some difficulties with the last one. The number and types of students trained in FRAMPs fluctuate widely, as do the policies governing the kind of training received by different types of students and the points in their careers at which they receive it. The figures used in the following analysis are based on estimates provided by VA-122 and VA-174 at various times over the past 4 years. The overall figures for the power plant and structures/hydraulics maintenance technicians were checked against NITRAS figures for the relevant NAMTRADET courses.

Savings in Major Training Pipelines

Table 8 provides estimates of the savings provided by shortening the major technical training pipelines leading to each of the three billets (see Figure 1). For the power plant and structures/hydraulics maintenance technicians, the pipelines consist of preparatory courses, initial skill courses, and FRAMP training. For the plane captains, the pipeline consists entirely of FRAMP training.

Since the training time represents time when students are not available for deployment, any reduction in the costs associated with this period is assumed to be a legitimate saving. The reduction in training time for the power plant and the structures/hydraulics maintenance technicians corresponds roughly to the time they would normally have spent at NATTC Memphis, so CNTECHTRA estimates of training costs in the relevant initial skill courses were used for estimating savings. In each case, the total cost is about $19,000 per student-year. Almost half of this represents student salaries and benefits; the remainder is divided between student support (e.g., barracks and mess) and training support (e.g., training equipment and pay for instructors and administrators). Similar cost estimates are not available for training in the readiness squadron but, considering the size of the base, student-to-instructor ratios, and training-equipment requirements, it seems safe to assume costs at least as large as those found in the initial skill courses. The average for all initial skill courses was used for estimating the cost savings provided by the job-specific plane captain training. The gross annual cost reduction in these three pipelines, computed as described, is $539,422.

Savings in Minor Training Pipelines

Table 8 does not consider the cross-training of technicians who have had experience in other aircraft or the training of initial skill course graduates who serve an initial tour of duty as plane captains. Estimates of savings for such training are given in Table 9.

Table 8

Savings in Major Training Pipelines

Item	Billet		
	Power Plant Maint. Tech.	Struct./Hyd. Maint. Tech.	Plane Captain
N Trained per year	44	100	372
Conv. training time (days)	76.4	85.9	35.0
Job-specific training time (days)	44.0	36.0	32.5
Relative reduction	42%	58%	7%
Absolute reduction (man-years)	5.7	19.8	3.7
Savings ($)	108,159	372,230	59,033

Note. The relative differences in days are smaller than the relative differences in hours reported earlier because of differences in the lengths of training days. At the time of the evaluation, the conventional training day was 8 hours. The training day for individualized portions of the job-specific courses was 7 hours for the structures/hydraulics maintenance technician courses and 7.5 hours for the power plant maintenance technician and plane captain courses.

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Table 9

Savings in Minor Training Pipelines

	Power Plant Maint. Tech.		Struct./Hyd. Maint. Tech.		Plane Captain	
Item	From Other Aircraft	From Plane Captain Course	From Other Aircraft	From Plane Captain Course	From Initial Skill Training	From Recruit Training
N trained per year	33.0	18.9	75.0	43.1	31.0	62.0
Conv. training time (days)	35.0	61.4	40.0	70.9	35.0	35.0
Job-specific training time (days)	30.4	24.0	27.1	16.8	28.2	32.5
Reduction	13%	61%	32%	76%	19%	7%
Difference (man-years)	.6	2.8	3.8	9.3	.8	.6
Savings ($)	9,636	53,629	61,413	173,934	13,381	9,839

The assumptions on which the estimates in Table 9 are based are more complex than for those required for students in the three major pipelines (e.g., the students who enter the plane captain courses from recruit training are the same as those who enter the power plant and structures/hydraulics maintenance technician courses from plane captain training). A detailed description of these assumptions is given in Appendix F.

Total Cost Reduction

The annual savings from Table 9 is $321,832. When added to the annual savings from Table 8, the total is $861,254. This is more than enough to pay for course development, initiation, and operation within the first year of use. After that, it would provide a net savings of over three-quarters of a million dollars a year for as long as the training requirements remain fairly stable, and a lesser savings as the aircraft phases out of the inventory.

Savings for Individual Billets

It is probably more meaningful, however, when evaluating costs, to consider the three billets separately. Plane captain training, because of its large input, accounts for over 50 percent of the total time spent under individualized instruction. However, the direct saving resulting from job-specific training for this billet is only about $82,000 a year. If operating costs are roughly proportionate to the number of students under training and if development costs are roughly proportionate to the length of training, it would require over 5 years before there was a net cost reduction.

The situation is much more favorable for the job-specific courses that replace common-core training. The power plant maintenance technician courses, in spite of an input of about 100 students a year, would pay for themselves in a little over 1 year, and thereafter would save approximately $150,000 a year. The structures/hydraulics maintenance technician courses would pay for themselves in a fraction of a year, and thereafter would save over $500,000 per year.

DISCUSSION

Effectiveness of Job-specific Training

All measures taken during or immediately after training indicate that students trained in the job-specific courses were better prepared for the duties they would perform on the job than were those trained in the conventional courses. However, there are a number of factors that might have negatively influenced the measured proficiency of the conventionally trained students. For example, most of the criteria were based on the training objectives developed for the job-specific courses, even though these did not correspond precisely to the objectives of the conventional courses. There are at least two ways in which this lack of correspondence might bias the study. The first arises from the possibility that the general objective of the job-specific courses, namely, to teach the student to perform the tasks that he will be assigned during his first enlistment, may not be an adequate general objective for courses of this kind. This is an extra-experimental issue, but it should be stressed that the various criteria pertain solely to this general objective. The second possibility for bias is that the specific training objectives are not both necessary and sufficient for the attainment of the general objective. The danger from this quarter was probably somewhat less in this study than it is in many studies because of the key role played by the tasks in the specification of both the specific and general objectives. In spite of occasional minor difficulties, these tasks represented a clear consensus of several different sources. Finally, the influence of certain relatively arbitrary decisions concerning the specific objectives may have been minimized by the fact that the terminal objectives were provided to FRAMP instructors during the period when data were being collected on the conventionally trained students.

Also, the delay between training and testing was less for students in the job-specific courses than for conventionally trained students. Students in the job-specific courses were given performance tests immediately after training, whereas students in the conventional courses were tested as much as 3 weeks after the completion of relevant training. However, students in the job-specific courses were performing these tasks for the first time, whereas the conventionally trained students frequently performed the tasks during training, so the test represented their second attempt. It would be difficult to balance the conflicting effects of recency and increased practice. For written tests, the difference in delays was even more extreme. Students in the job-specific courses were tested periodically within the courses, so the maximum delay between training and testing was no more than about 1 week. Conventionally trained students were tested at the end of training. For material taught in initial skill courses, this created a delay of as much as 3 to 4 months between original training and testing. Even for material taught in specialized courses, the delay may have been as much as 5 weeks. It should be noted, though, that these items did not cover all initial skill and specialized instruction; they were limited to knowledge that is closely related to the tasks taught in FRAMP, and this knowledge should have been reinforced repeatedly during the last few weeks before the test.

In view of the above, it may be best to focus on the absolute rather than the relative standings of the students trained in job-specific courses. Students trained in these courses were near the ceiling on each of the measures used, particularly on measures of their ability to perform the tasks they would be assigned during their first enlistment. The students' supervisors on the job were less uniform in their ratings, but interpretation of these data should be tempered by the fact that rated maintenance proficiency is often found to be relatively independent of measured maintenance proficiency. In any case, the supervisor questionnaires suggest that students trained in job-specific courses were reasonably proficient and that their performance was not substantially different from that of the conventionally trained students.

Feasibility of Job-specific Training

Job-specific training is feasible from both a practical and an economic point of view. Many of the difficulties and costs associated with small student inputs can be avoided through individualized instruction, computer support, and the sharing of learning centers by students in different courses. Most of the general problems (e.g., difficulties in scheduling equipment) are also found in conventional courses.

Use of Students After Job-specific Training

Although a high percentage of the students in this study could not be evaluated on the job because they were working in billets other than those for which they had been trained, an examination of the particular misassignments suggests that the problem is not as serious as it appears. Some information concerning actual assignments was available for 21 of the 26 students from the power plant and structures/hydraulics courses who were misassigned. Of these, 14 were assigned to plane captain billets. Another 6 were assigned to jobs as helpers in other areas. In either case, the jobs are generally filled on a temporary basis; technicians rarely remain in such a job beyond their first deployment, even if they have not received specialized training for a particular rating. When they have received such training, they will almost always be transferred to the billet for which they have been trained; therefore, most of these technicians would eventually profit from their specialized training. Only one student was trained for one permanent billet and assigned to another.

Since the plane captain billet is temporary, it might be assumed that training for the billet would carry less weight in assignments than would training for a relatively permanent billet. Even so, the total rate of misassignments from the plane captain courses was only about 16 percent.

Since essentially all misassignments were to temporary jobs of one kind or another, it might be best to train the technician for the temporary job (if training is available) prior to his initial deployment and then train him for his subsequent assignment during the interval between his first and second deployment. Certain squadrons do this; others, however, are reluctant to relinquish a technician to FRAMP once he has started work in the squadron. As a result, these squadrons must provide on-the-job training for one or the other of the two jobs in such a sequence.

Job-specific Training for Other Billets

The reductions in training time achieved in this project resulted from changes in both course content and training method. The contributions of these two factors cannot be clearly separated, but it is obvious that major reductions in power plant and structures/hydraulics maintenance technician training times were due to changes in

course content. In both cases, large quantities of material taught in the initial skill courses were completely eliminated from the curriculum. Large changes of this kind are possible when a common-core course has been extended to cover material that is not truly common to all billets served by the course, or when the need to serve a variety of billets has driven the level of abstraction above the level that is most effective in meeting real training requirements. The opportunity for such changes will vary widely over courses, and there will be courses for which the reduction in training time provided by job-specific training will not be sufficient to offset the advantages of common-core training or the cost of developing job-specific training materials.

The most cost-effective system for Navy training would probably be a hybrid system, consisting of a combination of job-specific and common-core courses. To estimate the optimal proportions in such a mix or the savings it might afford would require a detailed analysis of a broad sample of individual billets and courses.

Related Elements of the Personnel System

Any program of job-specific training, even if implemented on a limited basis, would interact strongly with other parts of the personnel system.

Initial Assignments

The misassignment of students trained in job-specific courses was not the problem in this evaluation that it has been in previous evaluations, but the close coordination between FRAMP and the operational squadrons provided a much tighter link between training and assignment than would normally be found in other parts of the Navy. This link had two distinct components: (1) the assignment to an operational activity prior to any technical training, and (2) the selection of a specific training program by the operational activity. When the activity assigns essentially all entry-level technicians in a given rating to the same job, the first of these components would be sufficient for proper course assignments. When the activity assigns such technicians to a variety of jobs, both components would be required.

A mechanism for the selection of specialized training by the activity already exists in the aviation community and in part of the submarine community. Functionally equivalent mechanisms could probably be established for other parts of the Navy without major difficulty. If such selections are to provide a basis for job-specific training, however, assignments to the operational activity must be made during recruit training instead of during initial skill training as they are now. Changes of this kind were made during this evalution without difficulty or ill effect but, in this particular case, the interval between assignment and arrival on the job did not increase and there was essentially no attrition. Substantially longer job-specific training sequences, particularly if they are associated with high levels of attrition, would pose a real problem.

Changes in Assignment

A training system should be evaluated not only in terms of its effect on performance in initial assignments, but also in terms of its effect on performance in subsequent assignments. In the absence of additional training, a technician who has been narrowly trained for one specific job might be less able to transfer his skill and knowledge to a new assignment than would a technician who has been more broadly trained in one of the existing initial skill courses. The scope of this particular problem is limited, however, by the frequency and timing of the job changes that actually occur. Apart from relatively

brief temporary assignments, most technicians remain in essentially the same job throughout their first enlistments. Only 10 to 20 percent remain in the Navy beyond their first enlistment. Most who reenlist receive advanced training in their rating and, since this advanced training is normally very general (for the same reasons that the initial skill courses are general), it would probably eliminate most differences in transfer resulting from differences in the technician's original training.

Even when the technician does change from one relatively permanent job to another without additional training, the transfer provided by common-core training may not differ substantially from that provided by job-specific training. Much of the material in a common-core course may be no more relevant to the second job than to the first. On the other hand, much of the material in job-specific courses is fairly general and might readily transfer to a number of related jobs.

Training as an Incentive

Job-specific training might be less of an incentive for enlisting in the Navy than would more general technical training with greater applicability to civilian jobs. If the longer, more general training programs were postponed, however, they might provide an effective incentive for reenlisting.

Advancement in Rating Examinations

For most promotions to PO3 or above, the technician must take an Advancement in Rating Examination. The same examination is taken by everyone in the rating who is seeking promotion to a given rate. The problems in constructing these examinations are similar to the problems in developing a common-core course for the rating. Many questions pertain to equipment or tasks the technician will never encounter on the job, and others are at a level of abstraction far above that actually required for effective performance on the job. Because of this similarity, the common-core initial skill course generally provides an excellent preparation for the examination, and the technician without such preparation suffers a distinct disadvantage. Inequities of this kind exist in the present system, but the technicians who have not attended initial skill courses tend to be distributed fairly evenly over various activities. If job-specific training were implemented for certain billets within a rating but not for all of them, these inequities would be concentrated in specific activities. The alternative is to revise the examinations so they cover only material needed on the job--but this has been advocated repeatedly, at least for technicians in their first enlistment, to no avail.

Resources Needed for Job-specific Training

Equipment Requirements

The courses developed for this evaluation were highly dependent on the use of both operational equipment and specialized training devices. Similar dependencies will be found in many job-specific courses. Where extensive programs for billet-oriented specialized training already exist (e.g., in the aviation community or the fleet ba[illegible] missile program), much of the necessary equipment may already be available. In other cases, the requirements can be met through the use of low-cost simulators. In general, though, a broad program of job-specific training would probably lead to substa[illegible] increases in requirements for training equipment. For some billets, the cost [illegible] may be sufficient to preclude a job-specific training program of the kin[illegible] study.

Job-specific and Common-core Course Development

A program for the development of job-specific courses would require close coordination with existing programs for the development or revision of common-core courses. As new job-specific courses were developed, students would be diverted from existing common-core courses, and this would probably change priorities for the revision of these courses. It is less likely that a major revision would be made if the number of students who take the course would be reduced substantially within a few years. On the other hand, changes of this kind might create a need for other kinds of revision. Marginal material that was originally included for the benefit of students who are no longer assigned to the course might be eliminated, and other material that was not sufficiently common for inclusion in the original course might become truly common for a new, more homogeneous population of students. Coordination of this kind would be facilitated by an early investment in the identification of billets that are the most promising candidates for job-specific training.

It would be convenient if both kinds of development were done by a single organization or at least under the direction of a single organization. This would simplify coordination of the kind discussed above, as well as coordination with outside organizations, such as the operational units, the activities that actually provide the training, and the Naval Military Personnel Command (NMPC), which handles the assignments. However, centralization of this kind would be complicated by the fact that responsibility for various elements of the training system is now distributed over a number of fairly autonomous organizations in different commands.

Funding Coordination

This evaluation suggests that many billets should be considered as candidates for job-specific training and that the potential cost reduction is very large. However, the cost of developing and supporting such courses, though less than the potential cost saving, would also be very large. The funding of such a program would be complicated by the fact that costs and cost reduction would have their major impacts on different budgets. The major costs would be borne by the Naval Education and Training Command. The major saving, on the other hand, would accrue to NMPC. Such a fiscal separation makes it much more difficult to transform cost savings into the capital required to finance a program of this kind.

CONCLUSIONS

Previous studies have indicated that training sequences tailored to the requirements of specific jobs can reduce training times substantially without adversely affecting the proficiency of graduates on the job. The present study provides additional examples of such reductions. It also demonstrates that many of the problems associated with the small student inputs to job-specific courses can be alleviated through the use of an individualized, computer-managed training system. Finally, it demonstrates that the costs of developing job-specific courses, even when annual student inputs to the courses are fairly small, can be recovered within a reasonably short period of time.

No serious obstacles to job-specific training were encountered in the course of this study, but there are several potential difficulties that might occur outside this rather limited scope. Some of these might even preclude job-specific training for certain billets. Others would necessitate revisions in various elements of the personnel system. However,

none of these difficulties appear serious enough to offset the large reduction in training cost that might be provided by job-specific training.

RECOMMENDATIONS

1. Training for a representative sample of billets should be analyzed to (a) estimate the potential benefits of a broad program of job-specific training and (b) identify candidates for conversion to job-specific training. There is a particular need for information on the way in which training of this kind would work with billets on surface ships.

2. Job-specific training programs should be initiated for several billets where there are relatively few obstacles to implementation and large potentials for cost reduction. The programs developed under this project should be considered prime candidates, since (a) most of the developmental work has already been done and (b) major changes in other parts of the personnel system would not be necessary. Consideration should be given to implementing these programs on the aviation training support system, a system of small on-site computers being developed at the Naval Weapons Center, China Lake.

3. A systematic analysis should be made of the ways in which a broad program of job-specific training would interact with recruiting, detailing, cross training, advanced training, advancement in rating, reenlistment, and career progression. Consideration should be given to modifications of existing procedures that might serve to facilitate job-specific training.

APPENDIX A

CONTENT OF PREPARATORY, INITIAL SKILL, AND SPECIALIZED TRAINING COURSES PROVIDED FOR THE BILLETS INCLUDED IN THIS STUDY

PREPARATORY COURSES

Aviation Familiarization Course

1. Military aircraft designation system
2. Basic theory of flight and aircraft nomenclature
3. Aircraft handling crews, securing devices, and safety in line operations
4. Aviation support equipment
5. Naval aviation rating familiarization
6. Aircraft carriers
7. Aircraft firefighting
8. Naval aviation organizations
9. Standard aircraft taxi signals
10. Basic aircraft systems
11. Aircraft cleaning
12. Aviation fuels, oils, and hydraulic fluid

Aviation Mechanical Fundamentals Course

1. Naval aviation maintenance program
2. Work unit code manual
3. Maintenance requirement cards
4. Corrosion
5. Mechanics of heat and gases, static electricity, and basic hydraulics
6. Addition, subtraction, multiplication, and division of fractions
7. Addition, subtraction, multiplication, and division of decimals
8. Support action form
9. Single-copy maintenance action form
10. Aircraft hardware
11. Wrenches
12. Screwdrivers and pliers
13. Measuring and marking tools and drills
14. Vises, files, and hacksaws
15. Punches, chisels, and striking tools
16. Maintenance and operation manuals
17. Multicopy maintenance action form
18. Torque wrenches
19. Shop I
20. Shop II

INITIAL SKILL COURSES

Aviation Machinist's Mate J (Jet Engine) Course, Class "A"

	Hours
Phase I. Turbojet Fundamentals	39
Unit 1. Apprentice Mechanic.	4

a. Course introduction
b. Apprentice mechanic billets

Unit 2. Basic Turbojet Powerplant Theory	25

a. Propulsion theory
b. Turbojet powerplant characteristics
c. Thrust development
d. Variable factors affecting thrust
e. Thrust augmentation
f. Turbojet powerplant designations

Unit 3. Flight and System Familiarization	10

a. Propellers
b. Helicopter theory
c. Turbojet systems introduction
d. Unified operating events

Phase II. Turbojet Powerplants	80
Unit 1. Turbojet Powerplant Familiarization	40

a. Turbojet familiarization
b. Bearings
c. Turbojet powerplant sections

Unit 2. Turbojet Powerplant Systems	40

a. General information
b. Air system
c. Fuel system
d. Fuel system maintenance
e. Lubrication system
f. Lubrication system maintenance
g. Starting system
h. Ignition system
i. Starting and ignition system maintenance
j. Hand tools

Hours

Phase III. Turbojet Powerplant and Aircraft Maintenance 80

a. Levels of maintenance
b. Powerplant build-up
c. Technical publications: purpose, identification, and application
d. Turbojet powerplants and aircraft maintenance inspections
e. Maintenance forms and related technical publications
f. Ground support equipment
g. Calendar inspection procedures

Phase IV. Line Familiarization and Turbojet Powerplant Operation 79

Unit 1. Plane Captain, Ground Support Equipment, Corrosion Control 39

a. Plane captain
b. Ground support equipment
c. Corrosion control

Unit 2. Inspections and Line Operations 40

a. Inspections
b. Line operations

Course Total 278

Aviation Structural Mechanic H (Hydraulics) Course, Class "A"

Phase I. Fundamentals 36

Unit 1. Familiarization 3

a. Course orientation
b. Student information

Unit 2. Aviation Publications and Material Procurement 20

a. Publications
b. Procurement

Unit 3. Application of the Maintenance and Material Management System . . 13

a. Functions of organizational level maintenance
b. Functions of AIMD level maintenance
c. Flow of work
d. Documentation of maintenance forms

	Hours
Phase II. Basic Hydraulics	100
Unit 1. Introduction to Hydraulics	23
a. Safety precautions b. Elementary principles of hydraulics c. Schematic interpretation d. Basic hydraulic system e. Rigid tubing and fittings f. Flexible hose and fittings g. Sealing devices/methods	
Unit 2. Power Systems	21
a. Safety precautions b. Power system components c. Fluid contamination	
Unit 3. Landing Gear Units	30
a. Safety precautions b. Brakes c. Landing gear shock struts d. Shimmy dampers	
Unit 4. Valves and Actuators	26
a. Safety precautions b. Valves c. Hydraulic actuators	
Phase III. Maintenance of Hydraulic Systems and Operational Maintenance	144
Unit 1. Maintenance of Hydraulic Systems	95
a. Safety precautions b. Maintenance publications c. Maintenance equipment d. Typical aircraft systems (high pressure)	
Unit 2. Operational Maintenance	49
a. Safety precautions b. Simulated organizational maintenance	
Course Total	280

Hours

Aviation Structural Mechanic S (Structures) Course, Class "A"

Phase I. Fundamentals 32

Unit 1. Familiarization 3

a. Course orientation
b. Student information

Unit 2. Aviation Publications and Material Procurement 29

a. Publications
b. Procurement
c. Documentation of applicable maintenance forms

Phase II. Aircraft Structural Repair 168

Unit 1. Basic Aircraft Sheet Metal Fabrication 40

a. Drawing interpretation
b. Safety precautions
c. Aircraft structural materials
d. Layout
e. Cutting and forming sheet metal
f. Drilling
g. Aircraft rivets
h. Structural repair information
i. Documentation of applicable maintenance forms

Unit 2. Repair of Stressed Skin 40

a. Safety precautions
b. Repair publications
c. Stressed skin areas
d. Flush patches
e. Countersinking
f. Rivet joints
g. Pneumatic riveting
h. Documentation of applicable maintenance forms

Unit 3. Repair of Internal Structures 40

a. Safety precautions
b. Bend allowance
c. Repair publications
d. Aircraft stringers and spars
e. Aircraft ribs and bulkheads
f. Sandwich construction materials
g. Documentation of applicable maintenance forms

Hours

Unit 4. Fabrication of Access Panels, Installation of Special Fasteners, and Maintenance of Integral Fuel Cells 48

a. Safety precautions
b. Repair publications
c. Requirements
d. Fastening devices
e. Fabrication procedures
f. Integral fuel cells
g. Documentation of applicable maintenance forms

Phase III. Nonmetallic Materials and Corrosion Control 64

Unit 1. Corrosion Control Procedures 28

a. Safety precautions
b. Repair publications
c. Nature of corrosion
d. Types
e. Detection
f. Paint removal
g. Corrosion removal
g. Prevention
i. Documentation of applicable maintenance forms

Unit 2. Aircraft Painting 24

a. Safety precautions
b. Repair publications
c. Paint equipment
d. Aircraft primer
e. Aircraft paints
f. Aircraft markings
g. Documentation of applicable maintenance forms

Unit 3. Plastics 12

a. Safety precautions
b. Types
c. Description
d. Uses
e. Repair publications
f. Panel replacement
g. Preventive maintenance
h. Documentation of applicable maintenance forms

Hours

Phase IV. Airframes and Operational Maintenance 80

Unit 1. Organizational Maintenance 48

a. Safety precautions
b. Aircraft inspections
c. Maintenance of aircraft arresting hooks
d. Servicing of aircraft
e. Aircraft flight control systems
f. Ground support equipment
g. Documentation of applicable maintenance forms

Unit 2. Intermediate Maintenance 32

a. Safety precautions
b. Maintenance induced accidents
c. Replacement of fluid lines
d. Fabrication of control cable assemblies
e. Maintenance of aircraft wheel and tire assemblies
f. Nondestructive inspection of metals
g. Documentation of applicable maintenance forms

Course Total 344

SPECIALIZED TRAINING COURSES

FRAMP Phase I. Introduction and General Training (Common)

Indoctrination and General Training 120

Unit 1. Indoctrination 16

a. Area orientation
b. Legal affairs
c. Serviceman's group life insurance (SGLI)
d. Financial management
e. Drug abuse/drug exemption program
f. Security briefing
g. Character guidance
h. Career counseling
i. Personnel service records

Unit 2. A7-E Aircraft Familiarization 24

a. Aircraft description
b. Environmental/egress systems
c. Powerplant and fuel systems
d. Hydraulic systems
e. Electrical systems
f. Avionics systems
g. Ordnance and armament
h. Line and aircraft safety (ashore and afloat)
i. Aircraft handling
j. Aircraft walkaround

	Hours
Unit 3. Basic/Refresher Maintenance Documentation	12
a. MAF b. SAF c. TDC	
Unit 4. Firefighting	16
Unit 5. Drivers Training (nondrivers exempted)	12
Unit 6. Ground Support Equipment (yellow gear)	40
Phase Total	120

<u>NAMTG TG41-A2 Power Plant and Related Systems Organizational Maintenance Course</u>

Phase I. Introduction, Maintenance Requirements, and Aircraft Fuel System	13
Unit 1. Introduction	4
a. Course introduction b. Technical publications c. Maintenance inspection requirements	
Unit 2. Engine systems	9
a. Fuel system description, operation, and servicing b. Fuel system maintenance	
Phase II. Engine Description and Systems	24
Unit 1. Engine Description	3
a. Engine introduction b. Engine sections	
Unit 2. Engine Systems	21
a. Air system b. Lubrication system c. Smoke abatement additive d. Electrical system e. Fuel system	
Phase III. Propulsion System Maintenance	43
Unit 1. Scheduled Maintenance	7
a. TF41 phased maintenance	

Hours

Unit 2. Operating Maintenance 36

a. Compressor half-case removal and installation
b. Engine rigging
c. Start and operation
d. Engine trim and operational checks
e. Corrosion recognition and preservation
f. Review and examination

Course Total 80

FRAMP Phase III. Supervised Practical Training for Organizational-level Power Plant Technicians

Unit 1. Introduction. 8

a. Publications
b. Safety
   (1) Shop spaces
   (2) Line and hangar deck
   (3) Aircraft
c. Applicable GSE
d. Foreign object damage (FOD)
e. Component location
f. Cockpit and seat checkout

Unit 2. Basic Troubleshooting Procedures 4

Unit 3. External Stores 8

a. Aero 1D
b. Buddy store

Unit 4. Inspections 8

a. Corrosion

Unit 5. Engine Wash 8

Unit 6. Review and Test 4

Unit 7. Engine System. 36

a. Engine removal
b. Engine installation
c. Engine start (turnup) procedures
d. Cockpit orientation trainer (COT)
e. Engine trim

Unit 8. Final Test and Review 4

Phase Total 80

Hours

NAMTG A7-E Hydraulic and Pneumatic Systems Organizational Maintenance Course

Phase I. Structure Maintenance 16

Unit 1. Airframe Components Inspection, Repair, and Maintenance 11

a. Airframe (fuselage)
b. Airframe (empennage)
c. Airframe (wing)
d. Wheels and tires
e. Fasteners

Unit 2. Airframe Nonmetallics, Inspection, Repair, and Maintenance 3

a. Plastics and associated materials
b. Fuel cells

Unit 3. Corrosion 2

a. Corrosion control

Phase II. Hydraulic and Pneumatic Systems Maintenance 36

Unit 1. Operation and Maintenance of Hydraulic Power Control Systems 9

a. Introduction to aircraft
b. PC-1 hydraulic power supply
c. PC-2 utility hydraulic power supply
d. PC-3 hydraulic power supply

Unit 2. Emergency Supply Systems 7

a. Utility emergency supply system
b. Accumulator precharging system
c. Emergency power package

Unit 3. PC-2/Utility Hydraulic Systems 20

a. A/R probe hydraulic system
b. M61A1 gun hydraulic system
c. Hydraulic and pneumatic systems and maintenance
d. Mid-term review and examination
e. Arresting gear system
f. Landing gear system
g. Wheel brake system
h. Nose gear steering system
i. Catapulting system

Hours

b. Explosive hazards
   (1) Ordnance
   (2) Liquid oxygen (LOX)
   (3) Fuel spills
c. Ground support equipment
   (1) Speed limits
   (2) Right of way
   (3) Foreign object damage (FOD)
   (4) Noise hazard--ear protection

Unit 3. A7-E Inspection Introduction 1

a. Daily inspection
b. Turnaround inspection
c. Conditional/special inspection

Unit 4. Electrical Power Application 1

Unit 5. Cockpit and Ejection Seat Checkout 2

Unit 6. Daily Inspection 3

a. Maintenance requirement card (MRC) deck
b. Daily maintenance record
c. Discrepancy cards
d. Naval flight record (yellow sheet), part A
e. Support action form

Unit 7. Aircraft Servicing 4

a. Pneumatic system
b. Hydraulic system
c. Engine oil
d. Constant speed drive (CSD)

Unit 8. Aircraft Fueling Operations 1

a. A7-E fuel system
b. Gravity fueling
c. Pressure fueling
d. Hot pressure fueling
e. Defueling
f. Fuel contamination

Unit 9. P/C--Pilot Hand Signals 4

a. Taxi--day and night
b. Launch--day and night
c. Recovery--day and night
d. Emergency--day and night

	Hours
Unit 10. Aircraft Launch and Preparation	3

a. Exterior walkaround
b. Pilot assist
c. Engine starting procedure
d. Prelaunch checks and hand signals

Unit 11. Aircraft Recovery Procedure	2

a. Hand signals
b. Accumulator pressurization
c. Shutdown procedure

Unit 12. Aircraft Securing	1

a. Protective covers
b. Tiedowns--all weather conditions

Unit 13. Hot Seating	1
Unit 14. Turnaround Inspection	3

a. MRC deck
b. Turnaround maintenance record
c. Discrepancy cards
d. Naval flight record (yellow sheet), part A
e. Support action form

Unit 15. Aircraft Spotting	2

a. Towing
   (1) Shipboard
   (2) Ashore
b. Brake riding
   (1) Shipboard
   (2) Ashore

Unit 16. Aircraft Cleaning and Corrosion Control	2

a. Preparation for wash rack
b. A/C washing procedures
c. Canopy and strut cleaning

Unit 17. Review and Test	3
Phase Total	40

	Hours
FRAMP Phase III. Supervised Practical Training for Plane Captains	
Unit 1. Daily Inspections	24
a. Cockpit checkout (COT) Cockpit Orientation Trainer	
(1) Ejection seat	
(2) Switchology	
b. Electrical power application	
c. Walkaround	
(1) Fuel sample	
(2) Hydraulic accumulators	
(3) Exterior light check	
(4) Tire pressure	
d. Servicing	
e. Documentation (minimum of 10 daily inspections for P/C qualification)	
Unit 2. Turnaround	25
a. Cockpit and switchology	
b. Walkaround	
c. Servicing (minium of 10 inspections for P/C qualification)	
Unit 3. Day Launch and Recovery (minimum of 10 for P/C Qualification). . .	10
Unit 4. Night Launch and Recovery (minimum of 10 for P/C Qualification) . .	10
Unit 5. A/C Securing Tie Downs Protective Covers	6
Unit 6. A/C Servicing	16
~~a. Techniques and equipment used~~	
Unit 7. Fueling	
a. Fueling techniques and procedures	
b. Defueling techniques and procedures	
c. Hot refueling	
(1) Techniques and procedures	
(2) Know function of each man involved	
Unit 8. A/C Hot Seating	4
a. Techniques and procedures	
b. Know function of each man involved	
Unit 9. Aircraft Cleaning and Corrosion Control	16
a. Wash rack	
b. Canopy and strut cleaning	
Phase Total	120

APPENDIX B

CONTENT OF JOB-SPECIFIC COURSES

<u>Code Categories</u>

PA = AFAM and AMFU

PB = AFAM and AMFU programs that required slight modification

PC = AFAM and AMFU programs that required major modification

F = FRAMP-type instructional materials developed expressly for the project

A = Initial skill type instructional materials developed expressly for the project

C = Specialized type instructional materials developed expressly for the project

A/V = Audiovisual

MODULES FOR POWER PLANT TECHNICIANS

Preparatory Course

PA 1. Naval aviation organization
PA 2. Aviation rating familiarization
PA 3. The military aircraft designation system
PB 4. Basic theory of flight and aircraft nomenclature
PA 5. Aviation fuels, oils, and hydraulic fluid
PB 6. Aircraft handling crews, securing devices, and safety in line operations
PA 7. Aviation support equipment
PA 8. Aircraft carriers
PA 9. Aircraft firefighting
PA 10. Fractions
PA 11. Decimals
PA 12. Aircraft hardware
PA 13. Screwdrivers and pliers
PA 14. Vises, files, and hacksaws
PA 15. Aircraft cleaning
PA 16. Standard aircraft taxi signals
PA 17. Wrenches
PA 18. Punches, chisels, and striking tools
PA 19. Measuring and marking tools and drills
PA 20. Shop I (A/V)
PB 21. Introduction to the naval aviation maintenance program
PC 22. The work unit code manual
PC 23. The support action form
PC 24. The maintenance action form (single-copy)
PC 25. The maintenance action form (multi-copy)
PA 26. Torque wrenches
PA 27. Shop II (A/V)
PC 28. Maintenance requirements cards
PC 29. Maintenance and operation manuals
PB 30. The mechanics of heat and gas, static electricity, and basic hydraulics
PA 31. Corrosion

Specific Billet Course

F 32. A-7E familiarization
F 33. Foreign object damage
F 34. A-7E aircraft and line safety
F 35. A-7E cockpit preentry safety check (A/V)
F 36. A-7E access panel numbering system
C 37. Introduction to the TF41A-2 powerplant
F 38. Tailpipe removal and installation (A/V)
F 39. Seventh-stage cooling air tubes inspection (A/V)
C 40. TF41A-2 powerplant lubrication system
F 41. Connecting external electrical power
F 42. Servicing the engine oil system (A/V)
43. The engine oil system inspection (A/V)
F 44. The oil cap security device inspection (A/V)
F 45. The magnetic chip detectors inspection (A/V)
C. 46. The main fuel system
C 47. The engine instrumentation and engine control systems

F. 48. The low-pressure fuel system inspection (A/V)
F 49. The HP fuel shutoff valve lubrication (A/V)
F 50. The throttle and control cambox inspections (A/V)
C 51. The A-7E aircraft fuel system
F 52. The gravity fueling check valve inspection (A/V)
F 53. Fuel hose inspection (A/V)
F 54. AERO 1-D installation and removal (A/V)
F 55. D-704 Installation and removal (A/V)
C 56. The TF41-A-2 accessories and drives
F 57. Draining, filling, and servicing the CSD (A/V)
C 58. Borescope inspection, Parts I, II, and III (A/V)
C 59. The TF41A-2 ignition and starting systems
F 60. The air turbine starter and hydraulic pumps inspection (A/V)
F 61. Starter oil draining and refilling (A/V)
A 62. The air logistics trailer (Model 4000A)
F 63. Powerplant removal, Part 1--disconnecting (A/V)
F 64. Powerplant removal, Part 2--removal (A/V)
F 65. Powerplant installation, Part 1--installation (A/V)
F 66. Powerplant installation, Part 2--hookup (A/V)
F 67. Checking the A-7E hydraulic reservoirs for proper servicing (A/V)
F 68. Engine static trim, Lesson 1--introduction (A/V)
F 69. Engine static trim, Lesson 2--preparation (A/V)
F 70. Engine static trim, Lesson 3--T5.1 datum point check (A/V)
F 71. Engine static trim, Lesson 4--mass airflow limiter check (A/V)

Lessons through 17 in modules 72 through 105 all pertain to dynamic engine trim.

F 72. Lesson 1--introduction (A/V)
F 73. Lesson 2--operating precautions and emergency shutdown (A/V)

Test Set Operator

F 74. Lesson 3, Part 1--engine prestart (A/V)
F 75. Lesson 4, Part 1—engine starting and shutdown (A/V)
F 76. Lesson 6, Part 1--engine limiter check (A/V)
F 77. Lesson 7, Part 1—idle speed check and adjustment (A/V)
F 78. Lesson 8, Part 1—P3 limiter check and adjustment (A/V)
F 79. Lesson 8, Part 1—acceleration and deceleration check and adjustment (A/V)
F 80. Lesson 10, Part 1—T5.1 datum point dynamic check and adjustment (A/V)
F 81. Lesson 11, Part 1—mass airflow limiter check and adjustment (A/V)
F 82. Lesson 12, Part 1—low pressure governor maximum speed adjustment (A/V)
F 83. Lesson 13, Part 1—bleed air system check and adjustment (A/V)
F 84. Lesson 15, Part 1—manual fuel control check (A/V)
F 85. Lesson 16, Part 1—power check (A/V)
F 86. Lesson 17, Part 1—engine postrun (A/V)

Engine Adjustment Assistant

F 87. Lesson 3, Part 3—engine prestart (A/V)
F 88. Lesson 4, Part 3—engine starting and shutdown (A/V)
F 89. Lesson 5, Part 2--fuel system bleeding (A/V)
F 90. Lesson 7, Part 2--idle speed check and adjustment (A/V)
F 91. Lesson 8, Part 2--P3 limiter check and adjustment (A/V)
F 92. Lesson 9, Part 2--acceleration and deceleration check and adjustment (A/V)

F 93. Lesson 10, Part 2--T5.1 datum point dynamic check and adjustment (A/V)
F 94. Lesson 11, Part 2--mass airflow limiter dynamic check and adjustment (A/V)
F 95. Lesson 12, Part 2--low pressure governor maximum speed adjustment (A/V)
F 96. Lesson 13, Part 2--bleed air system check and adjustment (A/V)
F 97. Lesson 15, Part 3--manual fuel control check (A/V)
F 98. Lesson 17, Part 3--engine postrun (A/V)

Cockpit Operator

F 99. Lesson 3, Part 2--engine prestart (A/V)
F 100. Lesson 4, Part 2--engine starting and shutdown (A/V)
F 101. Lesson 5, Part 1--fuel system bleeding (A/V)
F 102. Lesson 6, Part 2--engine limiter check (A/V)
F 103. Lesson 14, Part 1,--acceleration and deceleration response check (A/V)
F 104. Lesson 15, Part 2--manual fuel control check (A/V)
F 105. Lesson 17, Part 2--engine postrun (A/V)
A 106. Reading the depth micrometer
F 107. The spark igniters inspection (A/V)
F 108. The auto-relight switch inspection (A/V)
F 109. Engine wash (A/V)

MODULES FOR STRUCTURAL/HYDRAULICS TECHNICIANS

Preparatory Course

The preparatory course for structures/hydraulics technicians was the same as that for the power plant technicians with the exception of module 30, which has the following title:

PB 30. The mechanics of heat and gas and static electricity

Specific Billet Course

A 32. Basic hydraulic principles
A 33. Basic aircraft hydraulic systems
A 34. Hydraulic sealing devices
A 35. Aircraft tubing and fittings
A 36. Hydraulic power system components
A 37. Hydraulic actuating system components
F 38. A-7E familiarization
F 39. Foreign object damage
F 40. A-7E aircraft and line safety
F 41. A-7E cockpit preentry safety check (A/V)
F 42. A-7E access panel numbering system
F 43. Nose radome anti-static treatment (A/V)
A 44. Landing gear units
A 45. Introduction to aircraft wheels and tires
A 46. Introduction to aircraft jacks
C 47. The A-7E wheel brake system
F 48. Jacking the A-7E main landing gear (A/V)
F 49. A-7E main wheel and tire assembly removal and installation (A/V)
F 50. A-7E wheel brake system operational checkout (A/V)
F 51. Jacking the A-7E nose landing gear (A/V)
F 52. A-7E nose wheel and tire assembly removal and installation (A/V)

C 53. The A-7E power control hydraulic systems (A/V)
F 54. Connecting external electrical power
C 55. The A-7E AR probe system
F 56. The AR probe inspection (A/V)
F 57. Connecting external hydraulic power
F 58. The AR probe operational checkout (A/V)
C 59. The PC-1 hydraulic system (A/V)
C 60. The A-7E accumulator precharge system
F 61. Servicing the A-7E hydraulic accumulators (A/V)
A 62. The HSU-1 hydraulic servicing unit (A/V)
F 63. Checking the A-7E hydraulic reservoirs for proper servicing (A/V)
F 64. Servicing the PC-1 reservoir (A/V)
C 65. The PC-2 hydraulic system (A/V)
F 66. Servicing the PC-2 reservoir (A/V)
C 67. The PC-3 hydraulic system (A/V)
F 68. Servicing the PC-3 reservoir (A/V)
C 69. The A-7E arresting gear system
F 70. Servicing the arresting gear actuator (A/V)
C 71. The A-7E emergency power package
F 72. EPP operational checkout (A/V)
C 73. The A-7E wingfold system
F 74. The A-7E wingfold system operational checkout (A/V)
F 75. Wingfold support strut removal and installation (A/V)
A 76. Introduction to power control packages
A 77. Introduction to mechanical control components
C 78. The A-7E aileron control system
F 79. Servicing the lateral viscous damper (A/V)
F 80. The A-7E aileron rigging checkout (A/V)
F 81. The A-7E aileron power control system operational checkout (A/V)
C 82. The A-7E UHT control system
F 83. Servicing the forward viscous damper (A/V)
F 84. Servicing the aft viscous damper (A/V)
F 85. The A-7E UHT rigging checkout (A/V)
F 86. The A-7E UHT control system operational checkout (A/V)
C 87. The A-7E flap system
F 88. The A-7E flap control system operational checkout (A/V)
F 89. A-7E special inspections (A/V)
C 90. The A-7E rudder control system
F 91. The A-7E rudder rigging checkout (A/V)
F 92. The A-7E rudder control system operational checkout (A/V)
F 93. Jacking the A-7E aircraft (A/V)
C 94. The A-7E landing gear system
F 95. Landing gear operational checkout (A/V)
F 96. Arresting gear system operational checkout (A/V)
C 97. The A-7E nose gear steering system
F 98. The nose gear steering system operational checkout (A/V)
C 99. The A-7E catapulting system
F 100. The catapulting system operational checkout (A/V)
F 101. Servicing the main landing gear shock strut (A/V)
F 102. Servicing the nose landing gear shock strut (A/V)

MODULES FOR PLANE CAPTAINS

Preparatory Course

PA 1. Naval aviation organization
PA 2. Aviation rating familiarization
PA 3. The military aircraft designation system
PB 4. Basic theory of flight and aircraft nomenclature
PA 5. Aviation fuels, oils, and hydraulic fluid
PB 6. Aircraft handling, crews, securing devices, and safety in line operations
PA 7. Aviation support equipment
PA 8. Aircraft carriers
PA 9. Aircraft firefighting
PA 10. Aircraft hardware
PA 11. Screwdrivers and pliers
PA 12. Wrenches
PB 13. Introduction to the naval aviation maintenance program
PC 14. The support action form for the plane captain
PC 15. Lockwiring for the plane captain
PC 16. Maintenance requirements cards
PC 17. Maintenance and operation manuals for the plane captain
PA 18. Mechanics of heat and gases, static electricity, and basic hydraulics
PA 19. Corrosion

Specific Billet Course

F 20. A-7E familiarization
F 21. A-7E aircraft and line safety
F 22. Foreign object damage
F 23. A-7E cockpit preentry safety check (A/V)
F 24. Downlock removal and installation (A/V)
F 25. Wingfold support strut removal and installation (A/V)
F 26. Folding the wings using the hydraulic hand pump (A/V)
F 27. A-7E ordnance safety for the plane captain (A/V)
F 28. Securing an A-7E on the line (A/V)
F 29. Preparing and washing the A-7E aircraft (A/V)
F 30. Connecting external electrical power
F 31. Servicing the engine oil system (A/V)
F 32. Taking an oil sample (A/V)
F 33. A-7E hydraulics for the plane captain
F 34. Pressurizing the utility wheel brake accumulator (A/V)
F 35. Pressurizing the emergency wheel brake accumulator (A/V)
F 36. Preparing the A-7E for towing (A/V)
F 37. Securing an A-7E in the hangar (A/V)
F 38. Checking the A-7E hydraulic reservoirs for proper servicing (A/V)
F 39. Taxi signals (A/V)
F 40. Launch and recovery signals (A/V)
F 41. Strapping the pilot in the A-7E aircraft (A/V)
F 42. Launching an A-7E aircraft (A/V)
F 43. Recovering an A-7E aircraft (A/V)
F 44. The A-7E fuel system for plane captains
F 45. Fuel sampling
F 46. The A-7E turnaround inspection, Part I and II (A/V)
F 47. Extending and retracting the air refueling probe (A/V)

F 48. The A-7E daily inspection (A/V)
F 49. Retracting the arresting gear (A/V)
F 50. Hot fueling the A-7E aircraft (A/V)
F 51. Defueling the A-7E aircraft (A/V)
F 52. The HSU-1 servicing unit (A/V)
F 53. Servicing the PC-2 hydraulic reservoir (A/V)

INSTRUCTIONAL MATERIALS COMMON TO MORE THAN ONE OF THE SPECIFIC BILLET COURSES

Audio/Visual Programs	Courses
A-7E cockpit preentry safety check	All
Wingfold support strut removal and installation	PC, AM
Servicing the engine oil system	PC, AD
Checking the A-7E hydraulic reservoirs for proper servicing	All
The HSU-1 servicing unit	PC, AM
Programmed Text	
A-7E familiarization	All
A-7E aircraft and line safety	All
Foreign object damage	All
Connecting external electrical power	All
The A-7E access panel numbering system	AM, AD

APPENDIX C

PERFORMANCE TESTS

Table C-1

Performance of Students on Performance Tests

Performance Test	Number Tested		% Meeting Criterion		Time (min.)	
	Conv. Initial Skill	J-S Recruit	Conv. Initial Skill	J-S Recruit	Conv. Initial Skill	J-S Recruit
Power Plant Maintenance Technician						
Inspect gravity fueling check valve	3	17	100	100		
Inspect aircraft fuel hoses	3	15	33	100		
Remove and install tailpipe	2	6	50	100		
Inspect throttle and control cambox	2	15	0	100		
Wash engine	2	3	50	100		
Drain, fill. and serve CSD	2	13	0	100		
Drain and refill starter oil	3	20	100	100		
Lubricate HP fuel shutoff valve	2	20	100	100		
Inspect seventh stage cooling air tubes	3	12	33	100		
Inspect LP fuel system	1	19	0	100		
Inspect spark igniters	5	15	25	73		
Inspect auto-relight switch (using test set)	2	13	50	85		
Inspect magnetic chip detectors (using multimeter)	3	20	33	100		
Inspect engine oil system	2	14	50	86		
Adjust air logistics trailer	3	16	33	88		
Remove powerplant, Part I	2	12	50	92		
Remove powerplant, Part II	2	16	50	100		
Install powerplant, Part I	1	14	100	93		
Install powerplant, Part II	1	13	100	100		
Engine static trim	2	5	0	100		
Remove and install D-704	6	8	0	100		
Borescope inspection, Part I	3	10	33	100		
Borescope inspection, Part II	3	10	67	100		
Borescope inspection, Part III	1	9	100	100		
Cockpit preentry safety check	2	21	0	90		
Inspect oil cap security device	3	20	33	95		
Connect external electrical power	2	14	0	86		

Table C-1 (Continued)

Performance Test	Number Tested		% Meeting Criterion		Time (min.)	
	Conv. Initial Skill	J-S Recruit	Conv. Initial Skill	J-S Recruit	Conv. Initial Skill	J-S Recruit
Structures/Hydraulics Maintenance Technician						
Landing gear system operational checkout	6	18	100	100	123	87
Nose gear steering system operational checkout	6	18	100	100	42	31
Brake system operational checkout	9	16	100	100	37	38
Flap control system operational checkout	11	17	100	100	67	47
Rudder control system operational checkout	9	13	100	100	48	38
UHT control system operational checkout	9	17	100	100	157	59
Catapulting system operational checkout	10	14	100	100	38	35
Wingfold system operational checkout	12	17	100	100	32	37
Aileron rigging checkout	11	18	100	100	69	102
Service arresting gear actuator	4	18	100	100	37	46
Service PC-2 reservoir	11	17	100	100	22	18
Aileron power control system operational checkout	13	16	100	100	69	60
AR probe operational checkout	12	18	100	100	33	16
Service hydraulic accumulator	10	18	80	100	3	7
Connect external hydraulic power	8	15	88	100	17	28
Service nose landing gear shock strut	4	8	100	100	61	41
Service lateral viscous damper	8	18	100	100	26	23
Lubricate flap slot, flap hinge, and drag strut doors	4	17	100	100	20	18
Remove and install main wheel and tire assembly	7	17	100	100	46	77
Jack aircraft	6	14	100	100	38	32
Connect external electrical power	7	15	57	87	6	9

Table C-1 (Continued)

Performance Test	Number Tested: Conv. Initial Skill	Number Tested: J-S Recruit	% Meeting Criterion: Conv. Initial Skill	% Meeting Criterion: J-S Recruit	Time (min.): Conv. Initial Skill	Time (min.): J-S Recruit
Plane Captains						
Launch aircraft (day)	23	20	17	85	16	40
Recover aircraft	21	14	52	100	20	17
Daily inspection	24	21	58	100	53	68
Turnaround inspection, Part I	25	23	40	91	24	30
Turnaround Inspection, Part II	25	23	72	100	19	24
Pressurize emergency wheel brake accumulator (hand pump)	20	21	55	100	18	12
Extend and retract AR probe (hand pump)	21	21	67	100	16	15
Prepare aircraft for towing to hangar	23	22	70	100	11	9
Secure aircraft in hangar	17	23	82	100	9	9
Hot fuel	24	21	46	100	17	19
Service engine oil system	23	21	78	100	52	10
Prepare and wash aircraft	25	19	48	100	27	27
Cockpit preentry safety check	20	21	60	90	10	9
Connect external electrical power	21	20	76	100	20	11
Strap in pilot	5	22	100	100	16	11

APPENDIX D

RESPONSES TO ATTITUDE QUESTIONNAIRES

Note. The first 16 questionnaire items were administered to all students at the completion of training; items 17-21 were administered only to recruits in job-specific training; items 22-26 were administered only to conventionally trained power plant and structures/hydraulics technicians.

Table D-1

Responses (Percentages) to Student Questionnaires

	Power Plant Maint. Tech.		Structures/ Hydraulics Maint. Tech.		Plane Captain	
	Conv.	J-S	Conv.	J-S	Conv.	J-S
Item	Initial Skill (N=8)	Rec. (N=17)	Initial Skill (N=11)	Rec. (N=18)	Rec. (N=24)	Rec. (N=20)
1. I felt challenged to do my best work.						
a. Strongly disagree	0	6	0	11	4	5
b. Disagree	25	0	27	11	0	5
c. Uncertain	13	29	0	11	13	0
d. Agree	63	53	55	50	67	55
e. Strongly agree	0	12	18	17	17	35
2. I was concerned that I might not be understanding the material.						
a. Strongly agree	0	12	0	11	4	0
b. Agree	13	35	27	28	46	40
c. Uncertain	13	12	9	33	17	25
d. Disagree	75	41	55	28	33	25
e. Strongly disagree	0	0	9	0	0	10
3. I felt myself just trying to get throught the courses rather than trying to learn.						
a. All the time	0	0	0	6	4	0
b. Most of the time	0	0	9	0	0	15
c. Some of the time	25	35	36	11	29	25
d. Only occasionally	63	47	36	61	38	25
e. Never	13	18	18	22	29	35
4. I tried to learn as much as I could.						
a. Never	0	0	0	0	0	0
b. Only occasionally	0	0	0	6	4	0
c. Some of the time	25	6	9	6	4	15
d. Most of the time	38	41	73	44	63	45
e. All of the time	38	53	18	44	29	40
5. The material was easy to learn.						
a. Strongly disagree	0	6	0	6	4	5
b. Disagree	13	35	9	22	8	20
c. Uncertain	0	24	27	22	21	35
d. Agree	75	35	45	50	50	35
e. Strongly disagree	13	0	18	0	17	5
6. The material was difficult to remember.						
a. Strongly agree	0	0	0	11	0	5
b. Agree	25	35	18	28	17	15
c. Uncertain	0	24	18	22	21	20
d. Disagree	63	41	55	39	50	55
e. Strongly disagree	13	0	9	0	13	5
7. I felt frustrated by the way these courses were run.						
a. Strongly agree	25	18	18	11	13	35
b. Agree	25	29	18	6	25	30
c. Uncertain	13	24	27	17	13	15
d. Disagree	38	29	9	44	38	20
e. Strongly disagree	0	0	27	22	13	0
8. The material was presented effectively.						
a. Strongly disagree	0	6	9	6	0	10
b. Disagree	13	12	0	11	13	20
c. Uncertain	25	29	0	22	21	10
d. Agree	63	47	64	50	63	50
e. Strongly agree	0	6	27	11	4	10
9. I felt that too much was expected of me.						
a. Strongly agree	13	0	0	1	0	5
b. Agree	0	18	9	0	17	5
c. Uncertain	0	12	9	6	8	10
d. Disagree	88	71	64	72	58	65
e. Strongly disagree	0	0	18	17	17	15

Table D-1 (Continued)

Item	Power Plant Maint. Tech. Conv. Initial Skill (N=8)	Power Plant Maint. Tech. J-S Rec. (N=17)	Structures/ Hydraulics Maint. Tech. Conv. Initial Skill (N=11)	Structures/ Hydraulics Maint. Tech. J-S Rec. (N=18)	Plane Captain Conv. Rec. (N=24)	Plane Captain J-S Rec. (N=20)
10. It would have been helpful if I had received more hands-on practice here before being assigned to a squadron.						
a. Strongly agree	13	24	0	11	42	20
b. Agree	13	29	45	44	17	35
c. Uncertain	13	18	27	17	8	20
d. Disagree	50	24	27	28	25	20
e. Strongly disagree	13	6	0	0	8	5
11. I felt that some of the time I spent in training here at Lemoore was wasted and could have been spent more profitably in my squadron.						
a. Strongly agree	0	6	18	0	29	5
b. Agree	25	18	36	11	17	25
c. Uncertain	13	12	9	22	17	15
d. Disagree	50	47	18	33	38	45
e. Strongly disagree	13	18	18	33	16	10
12. I don't know whether or not I can really do some of the jobs that I have been taught here.						
a. Strongly agree	0	6	18	6	4	0
b. Agree	25	18	27	17	13	15
c. Uncertain	13	35	9	28	17	25
d. Disagree	25	35	36	33	50	50
e. Strongly disagree	38	6	9	17	17	10
13. When I reach the squadron, I will be ready to do the jobs that I have been taught here without further practice.						
a. None of them	0	0	0	6	4	5
b. Relatively few of them	13	18	18	0	8	0
c. Some of them	0	35	36	50	38	30
d. Most of them	50	47	45	39	33	55
e. All of them	38	0	0	6	17	10
14. I feel that my understanding of the aircraft will let me learn the new jobs that I will be taught in the squadron fairly quickly						
a. Strongly disagree	13	0	0	0	0	0
b. Disagree	0	6	0	11	0	5
c. Uncertain	0	6	9	11	13	0
d. Agree	75	65	64	61	71	65
e. Strongly agree	13	24	27	17	17	30
15. I felt that more time should have been spent trying to clear up parts of the job on which I was having trouble.						
a. Strongly agree	0	0	0	6	8	10
b. Agree	25	41	36	28	38	50
c. Uncertain	13	41	18	22	29	25
d. Disagree	63	18	45	44	21	10
e. Strongly disagree	0	0	0	0	4	5
16. By the time I took a performance test, I felt that I was really ready to do the job.						
a. Never	0	0	9	11	17	5
b. Only occasionally	13	0	0	17	0	5
c. Some of the time	13	29	27	39	29	30
d. Most of the time	38	65	55	22	42	55
e. All of the time	38	6	9	11	13	5

Table D-1 (Continued)

Item	Power Plant Maint. Tech. Conv. Initial Skill (N=8)	Power Plant Maint. Tech. 3-S Rec. (N=17)	Structures/Hydraulics Maint. Tech. Conv. Initial Skill (N=11)	Structures/Hydraulics Maint. Tech. 3-S Rec. (N=18)	Plane Captain Conv. Rec. (N=24)	Plane Captain 3-S Rec. (N=20)
17. I feel that I would have learned more on-the-job skills in "A" school rather than by CMI instruction.[a]						
a. Strongly agree	—	0	—	6	—	10
b. Agree	—	0	—	0	—	0
c. Uncertain	—	24	—	39	—	40
d. Disagree	—	53	—	39	—	40
e. Strongly disagree	—	24	—	17	—	10
18. I feel that I would be better prepared to work in an A-7E squadron if I had attended "A" school rather than CMI in the FRAMP.[a]						
a. Strongly agree	—	6	—	6	—	5
b. Agree	—	0	—	0	—	10
c. Uncertain	—	18	—	50	—	25
d. Disagree	—	65	—	39	—	40
e. Strongly disagree	—	12	—	6	—	20
19. It was easier for me to learn material by using audio/visual presentations rather than by using programmed instruction booklets.[a]						
a. Strongly agree	—	24	—	22	—	25
b. Agree	—	47	—	22	—	40
c. Uncertain	—	29	—	28	—	10
d. Disagree	—	0	—	11	—	15
e. Strongly disagree	—	0	—	17	—	10
20. I feel that more supervision of my on-the-job training was needed.[a]						
a. Strongly agree	—	12	—	6	—	15
b. Agree	—	12	—	11	—	35
c. Uncertain	—	24	—	6	—	5
d. Disagree	—	47	—	78	—	40
e. Strongly disagree	—	6	—	0	—	5
21. I think that there was not enough motivation for me to want to progress through the course as fast as possible.[a]						
a. Strongly agree	—	0	—	0	—	15
b. Agree	—	41	—	17	—	15
c. Uncertain	—	29	—	11	—	0
d. Disagree	—	29	—	50	—	55
e. Strongly disagree	—	0	—	22	—	15
22. I felt that the material I was taught in the NAMTRADET helped me to do the hands-on work in the hangar.[b]						
a. Not at all	0	—	0	—	—	—
b. Very little	0	—	27	—	—	—
c. A moderate amount	25	—	27	—	—	—
d. Quite a bit	50	—	27	—	—	—
e. Very much	25	—	18	—	—	—

[a] Items 17-21 were administered only to recruits in job-specific training.

[b] Items 22-26 were administered only to conventionally trained power plant (N = 7) and structured hydraulics (N = 9) maintenance technicians.

Table D-1 (Continued)

Item	Power Plant Maint. Tech. Conv. Initial Skill (N=8)	Power Plant Maint. Tech. J-S Rec. (N=17)	Structures/ Hydraulics Maint. Tech. Conv. Initial Skill (N=11)	Structures/ Hydraulics Maint. Tech. J-S Rec. (N=18)	Plane Captain Conv. Rec. (N=24)	Plane Captain J-S Rec. (N=20)
23. The material I learned in "A" school was a great help in learning the material that I was taught here.[b]						
a. Strongly disagree	29	—	33	—	—	—
b. Disagree	0	—	33	—	—	—
c. Uncertain	0	—	11	—	—	—
d. Agree	57	—	11	—	—	—
e. Strongly agree	14	—	11	—	—	—
24. The material taught in "A" school will be directly relevant to my work in an A-7E squadron.[b]						
a. Not of it	14	—	33	—	—	—
b. Very little of it	43	—	22	—	—	—
c. A moderate amount of it	0	—	44	—	—	—
d. A good deal of it	29	—	0	—	—	—
e. Most of it	14	—	0	—	—	—
25. There is duplication of the materials taught in the "A" school, NAMTRADET, and the FRAMP.[b]						
a. Very much	0	—	0	—	—	—
b. A good deal	14	—	11	—	—	—
c. A moderate amount	14	—	33	—	—	—
d. Very little	57	—	44	—	—	—
e. None	14	—	11	—	—	—
26. It would have helped if the material taught in "A" school could have been related more directly to the A-7E aircraft.[b]						
a. Strongly agree	14	—	100	—	—	—
b. Agree	14	—	0	—	—	—
c. Uncertain	0	—	0	—	—	—
d. Disagree	29	—	0	—	—	—
e. Strongly disagree	43	—	0	—	—	—

[b]Items 22-26 were administered only to conventionally trained power plant (N = 7) and structured hydraulics (N = 9) maintenance technicians.

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APPENDIX E

SUPERVISOR QUESTIONNAIRES

Table E-1

Questionnaire and Response Data (Percentages)

			Power Plant		Structures/ Hydraulics		Plane Captain	
			Conv. Initial Skill	J-S Rec.	Conv. Initial Skill	J-S Rec.	Conv. Rec.	J-S Rec.
1.	Do you directly supervise this man most of the time?							
	a.	Yes	100	100	60	100	95	70
	b.	No	0	0	40	0	5	30
2.	How long have you supervised this man?							
	a.	0-1 months	0	14	0	0	0	10
	b.	1-2 months	25	14	0	0	29	20
	c.	2-3 months	0	29	60	20	19	0
	d.	3 months or longer	75	43	40	80	52	70
3.	While this man has been under your supervision, has he received on-the-job training under more experienced maintenance men?							
	a.	Yes	100	100	100	80	100	100
	b.	No	0	0	0	20	0	0
4.	In your opinion, was the fundamental training he received in VA-122 adequate in scope for the work which he performed under your supervision?							
	a.	More than adequate	25	14	20	0	24	10
	b.	Adequate	25	57	20	80	71	40
	c.	Less than adequate	50	29	60	20	5	50
5.	What progress has this man made toward the competence you require of your men compared with other newly trained men you have supervised?							
	a.	More than adequate	25	43	40	80	50	30
	b.	Adequate	75	57	60	0	35	40
	c.	Less than adequate	0	0	0	20	15	30
6.	How does this man's motivation or initiative compare with other newly trained men you have supervised?							
	a.	Highly motivated	25	71	60	60	55	50
	b.	Usually motivated	75	29	40	20	40	20
	c.	Never motivated	0	0	0	20	5	30
7.	In general, how does this man's proficiency compare with other newly trained men you have supervised?							
	a.	Highly proficient	25	29	40	80	45	30
	b.	Adequate	75	71	40	0	45	40
	c.	Not proficient	0	0	20	20	10	30

Table E-2

Supervisor Ratings Concerning Additional Training Required

Task	Rating[a] Conv. Initial Skill	J-S Rec.	% Assigned Conv. Initial Skill	J-S Rec.
Power Plant Maintenance Technicians (four conventionally trained and seven job-specific students)				
Inspect gravity fueling check valve	1.0	1.8	75	71
Inspect aircraft fuel hoses	1.0	1.6	50	71
Remove and install tailpipe	1.5	1.3	100	86
Inspect throttle	2.3	2.2	75	71
Wash engine	2.7	2.0	75	86
Drain, fill, and service CSD	1.5	1.5	100	86
Drain and refill starter oil	1.0	1.5	100	86
Inspect air turbine starter and hydraulic pumps	1.3	1.5	75	57
Inspect cambox	2.0	2.0	50	57
Check starter oil	1.3	1.7	100	100
Lubricate HP fuel shutoff valve	1.3	2.0	75	86
Inspect seventh stage cooling air tubes	2.3	1.5	100	57
Inspect LP fuel system	1.7	1.5	75	57
Inspect spark igniters	1.5	1.3	100	43
Inspect auto-relight switch (using test set)	2.0	2.0	75	43
Inspect magnetic chip detectors (using multimeter)	1.7	1.8	75	71
Make connections after engine installation	1.3	2.4	75	100
Inspect engine oil system	2.0	2.6	100	71
Service CSD	1.5	1.6	100	100
Service engine oil	1.0	1.2	100	71
Check PC-1, PC-2, and PC-3 reservoirs	1.0	2.3	75	86
Adjust air logistics trailer	1.3	2.1	75	100
Make disconnections prior to engine removal	1.3	2.4	75	100
Remove power plant	2.0	2.4	75	100
Install power plant	2.0	2.4	75	100
Engine static trim	3.0	2.3	75	57
Operate test set for dynamic trim	3.5	2.0	67	29
Turn up engine for dynamic trim	2.5	2.0	50	29
Remove aero I-D	2.0	1.7	75	86
Remove D-704	2.0	2.4	75	71
Cold section borescope inspection	1.7	2.7	100	43
Cockpit preentry safety check	1.0	1.8	75	86
Adjust engine for dynamic trim	2.5	2.0	67	33
Install aero I-D	1.7	1.7	75	100
Install D-704	1.7	2.3	75	86
Hot section borescope inspection	2.3	2.3	100	57
Inspect oil cap security device	1.3	1.6	75	100
Connect external electrical power	1.0	1.3	75	86

[a]Responses based on 4-point scale, where 1 = capable of performing job with no additional training and 4 = required a substantial amount of training before he would perform the job.

Table E-2 (Continued)

Task	Rating[a] Conv. Initial Skill	Rating[a] J-S Rec.	% Assigned Conv. Initial Skill	% Assigned J-S Rec.
Structures/Hydraulics Maintenance Technicians (five conventionally trained and five job-specific students)				
Landing gear system operational checkout	2.8	3.0	100	80
Nose gear steering system operational checkout	2.3	3.3	80	60
Brake system operational checkout	2.8	2.8	80	100
Flap control system operational checkout	2.8	3.3	100	80
Rudder control system operational checkout	3.0	3.3	80	80
UHT control system operational checkout	2.7	2.5	60	40
Catapulting system operational checkout	2.8	2.8	80	80
Wingfold system operational checkout	2.5	2.7	80	60
Aileron rigging checkout	3.3	4.0	60	20
Rudder rigging checkout	3.0	4.0	60	20
UHT rigging checkout	3.3	3.5	80	40
Service arresting gear actuator	2.2	2.4	100	100
Service PC-1 reservoir	1.2	1.2	100	100
Service PC-2 reservoir	1.2	1.2	100	100
Arresting gear system operational checkout	2.2	2.6	100	100
Aileron power control system operational checkout	2.5	2.5	80	40
AR probe operational checkout	2.4	2.5	100	40
EPP operational checkout	2.5	2.0	80	40
Service forward viscous damper	1.8	1.4	100	100
AR probe operational checkout	1.6	3.0	100	60
Service hydraulic accumulators	2.2	2.0	100	100
Treat nose radome with antistatic compound	1.0	1.8	50	80
Inspect MLG lower fitting bearing	1.8	2.8	100	80
Remove and install NLG wheel and tire assembly	1.2	1.6	100	100
Jack MLG	1.0	1.4	100	100
Cockpit preentry safety check	1.6	1.2	100	100
Connect external hydraulic power	1.4	1.6	100	100
Service PC-3 reservoir	1.2	1.2	100	100
Service main landing gear shock strut	2.0	2.3	100	80
Service nose landing gear shock strut	2.0	2.3	100	80
Service aft viscous damper	1.4	1.2	100	100
Service lateral viscous damper	1.8	1.2	100	100
Lubricate flap hinges	1.0	1.6	100	100
Lubricate flap slots and drag strut doors	1.2	1.6	100	100
Inspect launch bar bushing	1.4	3.0	100	60
Remove and install main wheel and tire assembly	1.4	1.8	100	100

[a]Responses based on 4-point scale, where 1 = capable of performing job with no additional training and 4 = required a substantial amount of training before he would perform the job.

Table E-2 (Continued)

Tasks	Rating[a] Conv. Initial Skill	J-S Rec.	% Assigned Conv. Initial Skill	J-S Rec.
Structures/Hydraulics Maintenance Technicians (Continued)				
Jack aircraft	1.6	1.8	100	80
Jack nose gear	1.4	1.6	100	100
Connect external electrical power	1.0	1.2	100	100
Install wingfold support struts	1.0	1.2	100	100
Plane Captains (21 conventionally trained and 10 job-specific students)				
Launch aircraft (day)	2.5	2.7	100	100
Launch aircraft (night)	2.8	2.7	100	90
Recover aircraft	2.2	2.6	100	100
Secure aircraft on line	1.8	2.0	100	100
Emergency procedures for fire on engine shutdown	2.5	2.3	85	100
Emergency procudres for fuel dump after electrical power	2.6	2.6	80	90
Daily inspection	2.4	2.2	100	100
Turnaround inspection	2.4	2.4	100	100
Install and remove wingfold support struts	1.7	1.6	100	100
Fold wings (hand pump)	2.1	2.1	100	90
Pressurize emergency wheel brake accumulator (hand pump)	2.2	2.0	85	100
Pressurize emergency brake accumulator (hand pump)	2.2	2.0	100	90
Retract arresting hook (hand pump)	2.1	1.9	100	100
Extend and retract AR probe (hand pump)	2.2	2.2	95	100
Prepare aircraft for towing to hangar	1.9	2.2	95	100
Secure aircraft in hangar	1.7	1.9	100	100
Hot fuel aircraft	2.2	2.4	100	100
Service engine oil system	2.3	2.3	42	80
Service hydraulic reservoir	2.0	2.3	42	80
Prepare and wash aircraft	2.1	2.0	100	90
Take oil sample	2.4	2.3	45	40
Cockpit preentry safety check	2.0	1.9	100	100
Connect external electrical power	1.7	1.6	95	100
Strap in pilot	1.8	1.8	100	100

[a]Responses based on 4-point scale, where 1 = capable of performing job with no additional training and 4 = required a substantial amount of training before he would perform the job.

APPENDIX F

SAVINGS IN MINOR TRAINING PIPELINES: ASSUMPTIONS

SAVINGS IN MINOR TRAINING PIPELINES: ASSUMPTIONS

The following analysis indicates the way in which estimates of savings in minor training pipelines (Table 9) were computed.

The largest variations in cost are associated with initial skill course graduates who receive training as plane captains. At the time of the study, there were relatively few students of this kind, but this was ' nusual. More recent estimates suggest that between 20 and 80 percent of the students trained as plane captain are in this category. The lower figure is used in the following analysis, since the higher figures are generally associated with reduced flow through the major training pipelines.

Part of the variations in cost for these students occurs in the plane captain courses themselves, where the size of the variations depends on the kind of training that the student has already received. Students who enter the job-specific plane captain training program after training in conventional preparatory and initial skill courses can bypass the preparatory course, since the material taught in this segment repeats material that they have already learned. Because of this, the reduction in training time for these students is somewhat larger than it was for the recruits considered previously. This would not be the case, however, for students who would normally have attended the AMS, AMH, or ADJ courses. It is assumed that these students would receive the equivalent of the preparatory and initial skill training in the job-specific courses. If it is further assumed that they would receive their plane captain training first, then the time required for this training should be the same as the time required by the recruits considered previously. Recent estimates suggest that approximately two-thirds of the initial skill course graduates trained as plane captains have attended one of these three schools, and this figure was used in computing the cost estimates reported in the last two columns of Table 9.

If students received job-specific training for both the plane captain billet and one of the more rating-related billets, the variations in cost would be larger for the more rating-related portions of the training. In estimating these costs for the job-specific courses, it is assumed that special assignment patterns would be used to minimize the overlap between the job-specific plane captain training and the job-specific structures/hydraulics and power plant maintenance technician training. Such patterns would reduce the preparatory courses to the modules on hand tools and would eliminate the materials on A7-E familiarization from the specific billet courses. The bulk of the training for the conventionally trained students would obviously consist of the preparatory and initial skill courses. The proper assumptions concerning training in FRAMP, however, are more problematic. Both Phase II (NAMTRADET) and Phase III (supervised practical) training would be required to ensure an initial proficiency on the job comparable to that of the students trained in the job-specific courses. The figures in Table 9 are based on the assumption that this training would be provided. However, there are students who receive only Phase II training. If this practice were followed for all students, then the total cost differences reported in Table 9 would be reduced by about $47,000.

Approximately 30 percent of the students in the structures/hydraulics and power plant courses are being transferred to the A7-E from other aircarft. Most of these are initial skill course graduates, and it is assumed that the remainder have gained equivalent knowledge and skills through experience on the job. These students are scheduled for all three phases of training in FRAMP, but occasionally some of the more experienced ones are excused from portions of the material. This complicates the estimation of costs, since as training times are reduced, the difference in the times required for the two types of training may also be reduced. However, piecemeal variations in course content can be handled much more efficiently in an individualized course than in a lock-step course. In

fact, there are instances in which excusing a student from a particular segment of a lock-step course has no effect on the time required to complete training. This advantage of the individualized courses should be more than enough to compensate for any tendency in the other direction. Therefore, the estimates provided in Table 9 are based on the conservative assumption that all students complete the entire training sequence without exception. For a conventionally trained student, this sequence consists of the three phases normally provided by FRAMP. For a student trained in the job-secific courses, it consists of Phase I training from which the material on A7-E familiarization has been deleted (since this material is covered in the specific billet courses) plus a specific billet course from which the modules on initial skill material have been deleted.

This leaves approximately 13 percent of the students in the structures/hydraulics and power plant courses unaccounted for. Rather than attempt an exhaustive quantification of all contributions to cost avoidance, it was decided to leave these remaining students as a cushion for variations in the preceding categories.

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